Volume 22, Number 3, February 15, 1968

NUCLEAR SCIENCE ABSTRACTS

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Index References

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  Radioactive chain of mass number 189,  21:10023
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Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

```
MONTH, M.
  Theory of gradient perturbations in AGS,  21:9872 (BNL-
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MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
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SHEEP
  radiation dosimetry in, measurement of lethal dose of x,
    21:8905(R) (AD-631189)
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    21:8905(R) (AD-631189)
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  determination of configuration of, for ventilation,
    21:8779(R) (AD-629928)
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    21:8782(R) (AD-631424)
  evaluation of fallout, for fire and air blast damage,
    21:8560 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
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8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

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UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
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    2)
  22298        21-9915   Nucl. News, 9: No. 12, 17-21 (Dec.
                           1966)
  22298        21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                           1967)
  23267        21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
                           1966)
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  23420        21-8764   Lancet, 2: 672-5(Sept. 24, 1966)
  23474        21-8528   Dep. mn. CFSTI $3.00 cy, $0.65 mn
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  23482        21-9471   Dep. mn. CFSTI $3.00 cy, $0.65 mn
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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 4293, 4295, 4308, 4344, 4415, 4514, 4516, 4545, 5454, 5774, and 5790.

3997 (AEEW-R-550) METHOD FOR THE DETERMINATION OF OXYGEN ISOTOPIC RATIOS IN HEAVY WATER. Robinson, B. K.; Symons, W. J. (Atomic Energy Establishment, Winfrith (England)). Sept. 1967. 8p. Dep. CFSTI. UK.

A method for oxygen isotopic analysis of heavy water, in order to determine suitable correction factors to be applied when measuring the deuterium content by a density method, is described. A small sample of water is reacted with guanidine hydrochloride and the carbon dioxide formed is collected for mass spectrometric isotopic analysis. ^{18}O content can be readily determined to ±2% relative deviation, but at low levels ^{17}O results are subject to errors of ±10%. (auth) (UK)

3998 (CEA-N-819) AUTOMATISATION D'UNE BATTERIE DE COLONNES ECHANGEUSES D'IONS POUR LE DOSAGE DU PLUTONIUM DANS LES MILIEUX BIOLOGIQUES. (Automation of a Battery of Ion Exchange Columns for the Determination of Pu in Biological Samples). Jeanmaire, Lucien; Ballada, Jean; Rigaudiere, Roger; Patti, Francois; Clanet, Frank (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct. 1967. 16p. (In French). Dep.

An apparatus is described that makes it possible to carry out automatically ten determinations of Pu simultaneously using ion exchange resins. The reagent feed with constant output is accomplished by plastic syphons. The different phases of the determination are controlled by a programmer. The first results showed that the automated technique leads to results identical with those from the manual technique although monitoring of the operation is much reduced. It is suggested that the apparatus can be used for other similar determinations. (tr-auth)

3999 (LA-DC-8866) DETERMINATION OF OXYGEN IN GERMANIUM BY ^{3}He ACTIVATION. Holm, D.; Briscoe, W.; Parker, J.; Sanders, Wm. Mort (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 10p. (CONF-671026-10). Dep. CFSTI.

From 14th Nuclear Science Symposium, Los Angeles, Calif.

The reactions $^{16}O(^{3}He, p)^{18}F$ and $^{12}C(^{3}He, ^{4}He)^{11}C$ enable measurements of very small amounts of oxygen and carbon in a matrix of high atomic number. The products are positron emitters with convenient half lives of 110 and 20.4 min, respectively. Germanium samples of various qualities were analyzed for oxygen and carbon using this technique in an attempt to establish a correlation between the level of these contaminants and the performance of the material in detector applications. The contaminant levels observed were about 10 ppM and little or no correlation was observed. (auth)

4000 (RT/CHI-(67)15) UTILIZATION OF AN INDUCTION PLASMA IN THE ANALYSIS OF TRACES BY ATOMIC ABSORPTION. Biancifiori, M. A.; Bordonali, C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 34p. Dep.

Heating by induction plasmas in atomic absorption spectroscopy was studied. The plasma jet used was obtained by ionizing a current of argon at atmospheric pressure in a tube of dielectric material such as glass or quartz. Around the tube there is a coil in which a strong rf current flows creating a magnetic flux and an electric field. This electric field produces electric currents in the gas mass and disperses power by Joule effect. The maximum temperature of the gas at the center of the glow discharge is within 10,000 to 20,000°K. Advantages of the use of plasma are listed. Measurements were performed to test the system. The possibility of a considerable increase in sensitivity by operating in the presence of reducing agents was demonstrated. (M.C.G.)

4001 (RT/CHI-(67)16) DETERMINATION OF ^{54}Mn AND IRON IN LONG IRRADIATED STEEL SAMPLES. APPLICATION OF A LITHIUM-DRIFTED GERMANIUM DETECTOR. Moauro, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 16p. Dep.

A method is described for the direct determination of ^{54}Mn and iron in solutions of irradiated steel without separation of Ni, Cr, and other minor components. The method is simple and does not require more than 8 hr to be performed on 6 samples simultaneously. Gamma spectra with a very high resolution were obtained by using the Ge(Li) detector. This allowed the chemical separation to be reduced to the minimum necessary to eliminate the ^{60}Co which was present in preponderant quantities. Although the ^{54}Mn thus obtained was not completely pure, it was in quantitative yields, and the passage through the resin and the relative manipulations were appreciably reduced. (P.C.H.)

4002 (UCRL-17937) DEDUCTION OF PROVENIENCE OF POTTERY FROM TRACE ELEMENT ANALYSIS. Perlman, I.; Asaro, Frank (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1967. Contract W-7405-eng-48. 31p. Dep. CFSTI.

Neutron activation analysis was used to measure the abundance of 32 elements in pottery clays. A germanium counter was used rather than a NaI scintillation counter, and five types of materials from various areas were analyzed. Data for the abundance of Cs, U, Th, Cr, Co, La, Ni, Hf, Fe, Sc, and Sm in pottery excavated from various sites are presented. (D.H.M.)

4003 FORENSIC APPLICATIONS OF NEUTRON ACTIVATION ANALYSIS. Lyon, W. S.; Miller, F. J. Isotop. Radiat. Technol., 4: 325-40(Summer 1967).

The sensitivity and nondestructiveness of neutron activation analysis have made it an attractive technique for forensic scientists. Much work has been done on the unique identification of individuals by hair comparison. Information has been obtained as to normal and abnormal levels of trace elements in hair. The many possible sources of error in the procedure are discussed, and the necessity for establishing a firm scientific basis for identification is shown. Other possible areas of neutron activation analysis use in the identification of various materials as to origin are cited and discussed briefly. The availability of neutron activation analysis services for law-enforcement agencies and for private individuals is listed, and the costs of equipping a NAA laboratory are reviewed. (auth)

4004 THIN-LAYER CHROMATOGRAPHY IN INORGANIC ANALYSIS. Ryabchikov, D. I.; Volynets, M. P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Isotop. Radiat. Technol., 4: 362-6(Summer 1967).

The literature on inorganic thin-layer chromatography (83 references) since 1960 is reviewed. The survey indicated that this technique could be used more extensively than it is now for inorganic analysis and is especially valuable for handling of micro amounts of material and for performing basic theoretical studies. (auth)

4005 CONTINUOUS DETERMINATION OF THE HYDROGEN CONTENT OF LIQUID HYDROCARBONS BY MEANS OF

NEUTRONS. Johannes, Eberhard (VEB Vakutronik WIB, Dresden); Jaeckel, Hans Joachim. Chem. Tech. (Leipzig), 19: 30-4(Jan. 1967). (In German).

On the basis of laboratory and operational studies it was shown that, in comparison with other methods, the neutron slowing-down method offers favorable prerequisites for a commercial continuous oxygen determination. The construction of the measurement probe permits its use under critical operational conditions such as, in circuits existing under high pressure, at increased temperature, and in explosive regions. The measurement error is ≤0.15 mass % so that the accuracy of the common combustion analysis was obtained and the method has the advantage of an immediate and continuous measurement reading. (tr-auth)

4006 SPECTROCHEMICAL ANALYSIS OF ZIRCONIUM AND ITS ALLOYS. IV. SPECTROGRAPHIC DETERMINATION OF ALLOYING ELEMENTS IN ZIRCALOY-2 BY THE POINT-TO-PLANE LOW VOLTAGE SPARK TECHNIQUE. Mizuno, Tomomi; Matsumura, Tetsuo. Nippon Kinzoku Gakkaishi, 31: 227-32(1967). (In Japanese).

A spectrographic method was developed for the simultaneous determination of Cr, Fe, Ni, and Sn in Zircaloy-2. Analyses were made on samples in the form of solid machined specimens 30 mm in diam. Spectra were excited with a low-voltage spark (multi-source-type) in an Ar atmosphere and recorded on a photographic plate with the Ebert mounting spectrograph. Zirconium was used to serve as the internal standard. Various kinds of counterelectrodes, such as graphite, Ag, Cu, Al, Zn, W, and Fe were investigated. Precision of the method was 3 to 7% in coefficient of variation and the method was accurate enough to be utilized to check compliance with specifications. (Rev. Met. Lit.)

4007 NONDESTRUCTIVE NEUTRON-ACTIVATION ANALYSIS OF HAIR. Forslev, Albert W. (Chicago Police Crime Lab.). J. Forensic Sci., 11: 217-32(Apr. 1966).

Use of neutron activation techniques in forensic studies is reviewed, particularly with reference to arsenic in hair. Effects of neutron radiation on human hair examined microscopically are reported. The advantages of neutron activation analysis over other methods of elemental analysis are outlined and discussed. (TSS)

4008 THE DETERMINATION OF THORIUM, LANTHANUM, AND SAMARIUM IN CERIUM(IV) NITRATE BY ACTIVATION ANALYSIS, WITH THE AID OF ELECTROPHORETIC FOCUSSING OF IONS. Op De Beeck, J. (Ghent Univ.). Anal. Chim. Acta, 40: 221-8(Feb. 1968).

Thorium, lanthanum, and cerium were determined in ammonium cerium(IV) nitrate. The chemical separation was carried out by electrophoretic focussing of ions (EFI) in a matter of minutes. The small amount of sample possible in this separation technique is the main limit for the sensitivity of the procedure. With an irradiation time of 2 hr at a thermal flux of 4×10^{11} n/cm^2/sec, the lower limits are: Th 0.1 μg; La 4×10^{-2} μg; Sm 5×10^{-3} μg. (auth)

4009 DETERMINATION OF BARIUM AND STRONTIUM IN SEA WATER. Andersen, Neil R.; Hume, David N. (Massachusetts Inst. of Tech., Cambridge). Contracts AT(30-1)-2174; AT(30-1)-3145; Nonr 2196(00); AT(30-1)-905. Anal. Chim. Acta, 40: 207-20(Feb. 1968). (MIT-905-94).

A process based on ion-exchange concentration and separation followed by flame photometry has been developed for the determination of strontium and barium at natural levels in sea water. These elements are stripped from 1-l samples of sea water by means of a cation exchange resin in the calcium form and selectively eluted with CyDTA and EDTA, respectively. Factors influencing the intensity of strontium and barium in hydrogen flames have been studied. The standard deviations of the method are 0.05 ppM for strontium and 0.6 ppB for barium and the accuracy of the method is more than sufficient to demonstrate clearly the variability of Sr/Cl and Ba/Cl ratios with depth and location. (auth)

4010 PRECISION ANALYSES OF MANGANESE IN ROCKS BY NEUTRON ACTIVATION ANALYSIS. Johansen, O.; Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). Anal. Chim. Acta, 40: 201-5(Feb. 1968).

A simple and rapid procedure for the determination of manganese in rocks by neutron activation and γ spectrometry is presented. The precision of the method calculated from analyses of standard rocks is of the order 1.5 to 2%, and an accuracy of ±2% is attainable. The method is applicable to most types of geological samples, and should be superior to conventional methods used in rock analysis. (auth)

4011 CHEMICAL GAMMA-RESONANCE SPECTROSCOPY. Goldanskii, V. I. (Inst. of Chemical Physics, Moscow). Angew. Chem. Int. Ed. Engl., 6: 830-43(Oct. 1967).

The basic physics of the Mössbauer effect, the characteristics of Mössbauer (gamma-resonance) spectra, and various applications of this type of spectroscopy are considered. Particular attention is paid to the fundamentals and development of chemical gamma-resonance spectroscopy as a technique for the resolution of problems in various fields of chemistry and biology and to the range of problems tackled in the laboratory of nuclear and radiation chemistry. Some reviews and monographs dealing with the application of the Mössbauer effect in chemistry are listed. (M.C.G.)

4012 NEUTRON ACTIVATION ANALYSIS OF Al IN THE HUMAN HAIR. Dubinskaya, N. A.; Tsirkunova, I. E. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 4, 3-10(1967). (In Russian).

An instrumental neutron activation method was developed for determination of Al in human hair with a preliminary removing of Na from the hair during boiling in distilled water and with substracting of the interference from Mn in the analyzer memory. The sensitivity of the method equals to 0.1 g of Al. The error depends on the concentration of other elements and in this case does not exceed 10%. The concentration of Al in the investigated samples was found to equal 30 to 60 ppM. (auth)

4013 MICROGRAM DETERMINATION OF IODIDE BY THE USE OF ISOTOPIC EXCHANGE. Beronius, Per; Gabrielsson, Ann-Britt (Univ. of Umea, Sweden). Anal. Chim. Acta, 40: 352-3(Feb. 1968).

An exchange reaction is described for the determination of iodide. A known quantity of methyl iodide (n_1 moles) is mixed in a suitable solvent with the unknown amount (n_2 moles) of the inorganic iodide labeled with radioactive iodine. The radioactivity, A_0, of the sample is measured. After exchange equilibrium has been reached, the organic iodide is separated off and the remaining activity, A_∞ of the sample determined. The unknown quantity is calculated from the expression, $n_2 = n_1 A_\infty/(A_0 - A_\infty)$, which is derived on the assumption that the equilibrium constant of the exchange reaction is equal to unity. (P.C.H.)

4014 EFFECTS OF γ IRRADIATION ON SPECTROPHOTOMETRIC DETERMINATION OF URANIUM AS THIOCYANATE. Zittel, H. E.; Scroggie, L. E. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Anal. Chim. Acta, 40: 277-83(Feb. 1968). (ORNL-P-3175).

The effects of γ radiation on the spectrophotometric determination of uranium as the thiocyanate complex in water and acetone–water solutions have been studied. When tin(II) chloride is present, the absorbance of uranium thiocyanate in aqueous solution decreased with increasing radiation dose until the appearance of radiolytic elemental sulfur caused an apparent increase. In the absence of tin(II) chloride, the turbidity caused by radiolytic sulfur caused an increase in absorbance over the whole dose range studied. In acetone–water solution, similar but much more severe effects occurred. Observations of radiation effects on some of the individual reagents used in the spectrophotometric determinations are included, as well as indications of the errors caused by specific radiation doses. (auth)

4015 DETERMINATION OF BROMINE IN THE PRESENCE OF FLUORINE AND POSITRON EMITTERS USING FAST NEUTRON ACTIVATION ANALYSIS. Oldham, G.; Darrall, K. G. (Loughborough Univ. of Tech., Eng.). Anal. Chim. Acta, 40: 330-3(Feb. 1968).

Studies were made on the limits of usage of the 0.207-MeV peak from the ^{79m}Br ($t_{½}$ 5.0 sec)[2] for estimation under the worst possible interference conditions likely to be encountered from positron emitters. A value of approximately 10,000 counts/sec in the positron peak was taken as representative of the worst conditions under which such an analysis would be likely to be attempted. At the same time an investigation was made on possible interferences from other halogens and of these the only significant interference can come from the reaction ^{19}F(n,p)^{19}O. The method was also used to estimate the fluorine as well as the bromine. (P.C.H.)

4016 MEASUREMENT OF THE ABUNDANCE RATIO OF LITHIUM, URANIUM, AND COPPER ISOTOPES BY SURFACE IONIZATION METHOD. Kanzaki, Tadao (Tokyo Inst. of Tech.). Shitsuryo Bunseki, 14: No. 3, 127-34(Sept. 1966). (In Japanese).

Measurement of isotopic abundance ratios by surface ionization is advantageous because the amount of sample material required for the measurement can be small and it is also applicable for substances with lower vapor pressures. The purpose of such measurements is to determine the difference in the abundance ratios of a given sample and other ones. Consequently, an attempt was made to measure many samples with excellent precision and in a short time. Measurements were made of the abundance ratios of lithium, uranium and copper; an Atlas CH-4 mass spectrometer was used in the experiment. It is difficult to obtain the precise and reproducible abundance ratio of lithium, since the atomic weight of lithium is so small that its fractional evaporation cannot be ne-

glected. Among the chloride, iodide, nitrate, and sulfate of lithium, the iodide was found to be the most suitable for the purpose. The value of abundance ratios is influenced by the shape of an ionization chamber, the ionization current, the amount of used sample material, etc. It is difficult to measure the abundance ratio of copper precisely in a short time by surface ionization. (NSA of Japan)

4017 DERIVATIVE ACTIVATION ANALYSIS OF MAGNESIUM. Smathers, James B. (Walter Reed Inst., Washington, D. C.); Lakshmanan, Sitarama; Duffey, Dick. Trans. Amer. Nucl. Soc., 10: 448 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4018 DERIVATIVE NEUTRON ACTIVATION ANALYSIS OF FERROUS AND FERRIC IRON. Cheng, Francisco C. (Allis-Chalmers Mfg. Co., Bethesda, Md.); Lakshmanan, Sitarama; Duffey, Dick. Trans. Amer. Nucl. Soc., 10: 448-9 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4019 NEUTRON ACTIVATION ANALYSIS OF STABLE DYSPROSIUM BIOLOGICALLY DEPOSITED IN THE BONE OF CHINOOK SALMON FINGERLINGS. Babb, Albert L.; Miller, William P.; Wilson, William E. Jr.; Woodruff, Gene L.; Novotny, Anthony J. (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 10: 449 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4020 COMPLETE COMPUTER ANALYSIS OF NUMBERED GAMMA-RAY SPECTRA. Himes, David; Post, Roy G.; Wacks, Morton E. (Univ. of Arizona, Tucson). Trans. Amer. Nucl. Soc., 10: 449-50 (Nov. 1967).

From 15th Conference on Remoteeee Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4021 A GENERALIZED COMPUTER LIBRARY FOR NEUTRON ACTIVATION ANALYSIS. Campbell, W. W.; Robinson, E. L.; Furr, A. Keith (Virginia Polytechnic Inst., Blacksburg). Trans. Amer. Nucl. Soc., 10: 450 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4022 LIQUID-LOOP ACTIVATION ANALYSIS SYSTEM. Wood, D. E. (Kaman Nuclear, Colorado Springs, Colo.). Trans. Amer. Nucl. Soc., 10: 451 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4023 MICROANALYSIS OF SOLID FISSION PRODUCTS IN MIXED-OXIDE FUEL IRRADIATED IN EBR-II. O'Boyle, D. R.; Brown, F. L.; Sanecki, J. E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 462-3 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4024 ON THE DETERMINATION OF MICROAMOUNTS OF LEAD IN HIGH-ALLOY STEEL BY THE SPECTROPHOTOMETRIC METHOD. Sakaki, Takashi (Japan Special Steel Co., Ltd., Tokyo). Nippon Kinzoku Gakkai, 31: 1106-11 (1967). (In Japanese).

An experiment was carried out to establish a simple and accurate method for the determination of microamounts of lead in high alloy steel. The lead was separated as thionalide complex from the iron and other elements in an ammoniacal solution in which were masked those elements by use of ammonium tartrate, sodium cyanide and sodium sulfite. By means of this separation method with thionalide, the lead can be separated easily and accurately from large amounts of iron, manganese, nickel, chromium, molybdenum, copper, tungsten, vanadium, cobalt, titanium, aluminum, zirconium, and others. Niobium and tantalum were separated beforehand as pentaoxides from other elements by the hydrolysis method with sodium sulfite and tannic acid. The separated lead was determined by the spectrophotometric method with dithizone. As a result of the experiment, a method was established in which less than 0.005% of lead in high alloy steel can precisely be measured without difficulty. The lead contents in synthetic samples were measured by this method with satisfactory results. (auth)

4025 DIRECT TITRIMETRIC DETERMINATION OF MOLYBDENUM. Saxena, O. C. (Univ., Allahabad, India). Chim. Anal. (Paris), 49: 527-9 (Oct. 1967). (In French).

The direct titrimetric method for the estimation of molybdenum (VI) was described by decomposition and oxidation of the complex $[Mo^{VI}O_2, Mo^{V}O_2, Fe(CN)_6]$ with ceric sulfate. The mixed valency state in the complex is confirmed by magnetic measurements, the isolated complex being paramagnetic in nature. It is observed that Ag^{+}, Cs^{+}, Tl^{+}, Pb^{+}, Zn^{2+}, Hg^{2+}, Cu^{2+}, Co^{2+}, Ni^{2+}, Be^{2+}, Sn^{2+}, Pd^{2+}, Au^{3+}, Bi^{3+}, Sb^{3+}, In^{3+}, La^{3+}, Ir^{3+}, Rh^{3+}, Ru^{3+}, Pt^{4+}, Th^{4+}, Zr^{4+}, V^{5+}, U^{6+}, Se^{6+} and W^{6+} interfere. Ranges in which molybdenum was estimated vary from 0.0050 to 0.0002 g. (auth)

4026 ANALYTICAL CHEMISTRY OF BENZILIC ACID. Gupta, S. S.; Mukerjee, D. (Univ., Lucknow, India). Chim. Anal. (Paris), 49: 517-26 (Oct. 1967). (In French).

Sodium salt of benzilic acid precipitates a large number of mo-, di-, tri- and tetravalent metal ions giving a suitable method for their gravimetric estimations. They were formulated on the basis of conductivity, pH-, titrations, and quantitative estimations. The effect of pH on the precipitation and the minimum quantity that the reagent can precipitate were also observed. Tl^{3+}, Pb^{4+}, and Sn^{4+} were also precipitated quantitatively but reduced to their lower valency stage by the reagent. A large number of foreign ions interfered in the estimations and precipitates were soluble in most of the organic solvent except in ether and $CHCl_3$ and also were soluble in hot water. Insolubility of zinc benzilate in 5% alcohol was used in separation of this element from a large number of metal ions, 91 to 95% separation was possible. Silver benzilate and lead benzilate were extracted by n-butanol in presence of a large number of ions. They were separated by back washing with NaCl + HCl and 0.6 N H_2SO_4 respectively, 98 to 90% extraction were obtained. In each case, effect of pH, interference of other elements and the quantities that can be tolerated, reproductibility of the methods and the minimum quantity that can be separated were also observed. The utilities of benzilic acid in analytical chemistry were also summarized. (auth)

4027 RADIOCHEMICAL METHODS OF ANALYSIS. Rudenko, N. P. (Moscow State Univ.). Zh. Anal. Khim., 22: 1736-53 (Nov. 1967). (In Russian).

A brief review is given on radiochemical analysis. Radiochemical methods for determining elements in ultradilute solutions, concentration, coprecipitation, extraction and coextraction, chromatography, solubility of difficultly soluble elements, quantitative determination by means of isotope tracer, radiometric titration, and radiation absorption and neutron methods are discussed. (111 references.) R.V.J.

4028 MASS-SPECTRAL ANALYSIS. Tal'poze, V. L.; Khmel'nitskii, R. A. (Inst. of Chemical Physics, Moscow). Zh. Anal. Khim., 22: 1721-35 (Nov. 1967). (In Russian).

Extensive bibliographies on the development of spectral analysis and techniques are reviewed. The data cover mass analyzers, ion sources, correlation of molecular structure and mass spectra, and isotopic analyses. (226 references are included.) (R.V.J.)

4029 X-RAY SPECTRA ANALYSIS. Blokhin, M. A.; Il'in, N. P. (Rostov-on-Don State Univ., USSR. Moscow Inst. of Geochemistry and Analytical Chemistry). Zh. Anal. Khim., 22: 1711-20 (Nov. 1967). (In Russian).

X-ray spectral instrumentation and the methods and uses of x-ray spectral and micro-analysis are reviewed. (64 references are included.) (R.V.J.)

4030 DETERMINATION OF GOLD IN UNDERGROUND WATERS BY MEANS OF AN (n,γ) REACTION. Abdullaev, A. A.; Zakhidov, A. Sh.; Grakhov, V. A. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.- Mat. Nauk, No. 4, 66-8 (1967). (In Russian).

A multichannel γ spectrometer with a 40 × 40 mm NaI(Tl) crystal and a FEU-13 photomultiplier was used for measuring γ spectra in determination of gold by the (n,γ) reaction. The conditions for water specimen irradiation were selected considering the nuclear characteristics of ^{198}Au (θ = 100%, σ = 98 barns, $T_{\frac{1}{2}}$ = 2.8 days, and E_γ = 0.41 MeV). Calculations indicated 1.6×10^{-6} g/ml of gold in the water specimens from the Kyzylkum deposit and 5 to 71×10^{-9} g/ml in the specimens from other Uzbekistan regions. (R.V.J.)

4031 ON THE POSSIBILITY OF RHENIUM DETERMINATION BY RADIOACTIVATION ANALYSIS USING AMPULE NEUTRON SOURCES. Gureev, E. S.; Islamov, T.; Lobanov, E. M.; Miranskii, I. A.; Khaidarov, A. A. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 58-61 (1967). (In Russian).

Activation analysis with Po–Be and Ac–Be neutron sources were used to determine up to $\sim 10^{-4}$ and $\sim 10^{-3}$% rhenium. Concentrations up to $\sim 10^{-4}$% Re were determined with a Po–Be source after preliminary concentration and up to $\sim 10^{-5}$% after radiochemical treatment. With Ac–Be sources up to $\sim 10^{-3}$% rhenium was determined after preliminary concentration. The duration of the analytical procedure varied from 2 to 4 hr. (R.V.J.)

4032 HIGH-PRECISION DETERMINATION OF SILICON IN ROCKS BY FAST-NEUTRON ACTIVATION ANALYSIS. Vincent, H. A.; Volborth, A. (Univ. of Nevada, Reno). Nucl. Appl., 3: 753-7(Dec. 1967).

Silicon is determined by irradiating powdered rock samples with 14-MeV neutrons in a system that allows dual transfer of samples. The 1.78-MeV gammas of the ^{28}Al produced are counted as representing silicon in the sample. The unknown and reference sample positions for irradiation and counting are switched on consecutive irradiation count cycles with four of these cycles constituting a single determination. The standard deviation for a single determination is 0.12% silicon. Pure quartz is used as a reference. Results of analysis of some standard rock powders compare favorably with accepted values. New values are given for 10 standard rocks. (auth)

4033 MASS SPECTROMETRIC DETERMINATION OF ISOTOPIC RATIOS OF URANIUM AND FISSION PRODUCTS IN NEUTRON IRRADIATED URANIUM DIOXIDE. Inoue, Kiyoshi; Kobayashi, Tadao (Hitachi Ltd., Tokyo). Shitsuryo Bunseki, 14: No. 5, 265-74(Dec. 1966). (In Japanese).

A fundamental study was performed on the mass-spectrometric determination of the ratios of uranium and fission products in a uranium dioxide specimen irradiated in a nuclear reactor. The specimen dissolved in nitric acid was pipetted and evaporated to dryness on a filament, and then was analyzed in the single filament arrangement. By isotopic analysis of uranium, the contribution to burnup of the specimen by fission of ^{235}U was determined to be 4,370 MWd/t. The loss of ^{235}U in neutron capture reaction during irradiation was corrected by the ratio of ^{234}U to ^{235}U. The burnup of the specimen can be determined from the amount of a fission product formed during irradiation. Because of known contribution to the burnup by fission of ^{238}U, the contribution to burnup of the specimen by fission of ^{239}Pu might be determined by excessive formation of fission product. As the number of fissions of ^{239}Pu was estimated, burnup of the specimen was calculated as approximately 7,980 MWd/t. Experience with the mass-spectrometric analysis was obtained for the radioactive specimen. There was an increase in the emissivity of ion current at relatively low heating current through the filament in the pressure of beta emitters. (NSA of Japan)

4034 DETERMINATION OF ALL THE RARE EARTHS BY ACTIVATION ANALYSIS. APPLICATIONS TO NUCLEAR COMPOUNDS. Falcoff, R.; May, S.; Piccot, D. (Centre d'Etudes Nucleaires de Saclay, France). Bull. Soc. Chim. Fr., No. 9, 3257-66(Sept. 1967). (In French).

After irradiation in the EL 3 Saclay reactor, the samples were treated for rare earth group separation with lanthanum carrier. The rare earths were adsorbed on a resin Dowex 50 W × 8200 to 400 Mesh. Elution was performed at normal pressure and room temperature by α-hydroxyisobutyric acid with two pH gradients (2.7 to 3.1 and 3.1 to 4.3). The determination of each rare earth was made with the aid of a 400 channel analyzer and a INa (Tl) 4'' × 3'' crystal. With the first pH gradient the three first eluated rare earths (Lu − Yb − Tm) were satisfactorily separated. For a 72 hours irradiation in a flux of 1.8 10^{13} $n.cm^{-2}.s^{-1}$ the sensitivity was of the order of 10^{-6} μg for Eu and Sm, and 10^{-3} μg for Er and Nd. (auth)

4035 NEUTRON-TRANSMISSION METHOD FOR NON-DESTRUCTIVE DETERMINATION OF PLUTONIUM ISOTOPES IN FUEL ELEMENTS. Depisch, F.; Hick, H.; Weinzierl, P. Acta Phys. Austr., 25: 279(1967). (In German).

Measurement of neutron transmission in the energy region from 0.1 to 2 eV can be used to determine ^{239}Pu and ^{240}Pu in fuel elements. Measured isotope concentrations agreed within 5% with the value given by the manufacturer. (M.C.G.)

4036 DETERMINATION OF INDIUM IN ROCKS BY NEUTRON ACTIVATION ANALYSIS. Hamaguchi, Hiroshi (Tokyo Univ.); Tomura, Kenji; Onuma, Naoki; Higuchi, Hideo; Suda, Kazuo. Bunseki Kagaku, 16: 1233-8(Nov. 1967). (In Japanese).

Neutron activation methods were developed for determining indium in rocks to obtain more reliable and comprehensive geochemical figures about indium. Sample (ca. 0.4 g) and reference standard (0.1 μg In) were irradiated for one hour in the TRIGA Mark II Reactor of Rikkyo University with the neutron flux of 5 × 10^{11} $n/cm^2/sec$. After the irradiation, the sample was decomposed by $NH_4F \cdot HF - NH_4NO_3$ fusion in the presence of indium carrier (20 mg). The induced radionuclide from indium was separated and purified from the matrix by hydrobromic acid−ether extraction, followed by CuS and SiO_2 scavenging procedures. Finally, the indium was precipitated as sulfide and the β-activity of the purified isotope ^{116m}In was counted. The total time required for completion of the whole procedure was 90 min, and the average chemical yield was 50%. Some of the typical results obtained were (ppM In): G −1 0.026; W −1 0.057; Granites 0.042; Andesites 0.050; Basalts 0.083; Peridotites 0.025. Errors due to self-shielding and competing nuclear reactions $^{116}Sn(n,p)^{116}In$ were also discussed. (auth)

4037 THEORETICAL CONSIDERATION OF TENSAMMETRIC TITRATION CURVES. Fujinaga, Taitiro; Izutsu, Kosuke; Sawamoto, Hiromiti (Univ., Kyoto). Bunseki Kagaku, 16: 1188-92 (Nov. 1967). (In Japanese).

In amperometric titrations in very dilute solutions, it is difficult to obtain the equivalent point by the tangent method. It is desirable, therefore, to correct the experimental data by theoretical calculation. A general equation of the tensammetric titration curves for oxine−dilute metal ion systems is considered by taking into account the equilibrium conditions and the sensitivity limit of the measurement. The calculated titration curves agree well with experimental results reported previously. The applicability of these theoretical corrections are discussed for various metal ions. (auth)

4038 STUDY ON ANALYTICAL METHODS OF STEEL-MAKING MATERIALS. VI. VOLUMETRIC DETERMINATION OF NIOBIUM IN FERRONIOBIUM WITH OXINATE METHOD. Kajiyama, Rokuro; Watanabe, Masao; Yamaguchi, Katsumasa (Nippon Yakin Kogyo Co., Ltd., Daishigawara, Japan). Bunseki Kagaku, 16: 1156-9(Nov. 1967). (In Japanese).

Niobium was separated from tantalum by precipitating quantitatively with oxine from a solution of pH 4.5 containing ammonium tartrate. A sample was fused with potassium pyrosulfate, and niobium and tantalum were separated from the matrix elements as their hydroxides by the hydrolysis method. The precipitate was dissolved into a potassium hydroxide solution with hydrogen peroxide. Ammonium tartrate was added after decomposition of hydrogen peroxide by boiling, and the whole was diluted with water to a definite volume. An appropriate aliquot (corresponding to ca. 25 mg of Nb) was taken, EDTA and ammonium tartrate were added, and the pH was adjusted to 4.5. Niobium was precipitated by adding oxine. The precipitate was dissolved in hydrochloric acid, and niobium was determined by conventional bromate titration. The precipitate was assumed to have a composition $NbO(C_9H_6ON)_3$, 1 ml of 0.1 N potassium bromate solution corresponding to 0.7742 mg of niobium. Common impurities, less than 7.5% of aluminum, manganese, and tin, and less than 5% of titanium and tungsten did not interfere. (auth)

4039 DETERMINATION OF FLUORIDE BY THERMOMETRIC TITRATION. Everson, W. L.; Ramirez, Evelyn M. (Shell Development Co., Emeryville, Calif.). Anal. Chem., 39: 1771-80(Dec. 1967).

Thermometric titration is useful for determination of fluoride ions; the technique is simple, and repeatability and accuracy are reasonably good. It also provides a means for studying the general course and nature of metal-fluoride reactions. A number of cations were found to be suitable titrants; thorium, cerium, aluminum, and calcium are discussed. By selection of titrant and pH range, fluoride can be titrated in the presence of moderate to considerable amounts of sulfate, borate, phosphate, or silicate. (auth)

4040 DETERMINATION OF ZIRCONIUM IN ZIRCONIUM-BEARING SANDS AND ZIRCONIUM CONCENTRATES BY NON-DISPERSIVE X-RAY FLUORESCENCE METHOD. Holynska, B.; Langer, L. (Inst. of Nuclear Techniques, Krakow). Anal. Chim. Acta, 40: 115-22(1968).

A nondispersive x-ray fluorescence method for the rapid, nondestructive determination of zirconium in zirconium-bearing sands and zirconium concentrates is described. A ^{109}Cd source of primary radiation and compact geometry for measurements were used. The matrix effect from iron and titanium in sands was eliminated by measuring the fluorescent radiation of zirconium and the scattered primary radiation, and interpreting the data with nomograms. For concentrates, dilution with pure sand and measurement of the ratio of fluorescence to scattered radiation were used to reduce a matrix effect; a calibration curve was then satisfactory. Particle size effects were avoided by grinding to below 70 μ. (auth)

4041 THE PRECISE DETERMINATION OF ^{239}Np FOR THE EVALUATION OF ^{238}U CAPTURE CROSS-SECTIONS AT VARYING NEUTRON ENERGIES IN A ZERO-ENERGY FAST REACTOR. Large, R. S.; O'Connor, L. P. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Anal. Chim. Acta, 40: 123-30(1968).

A method is described for the determination of ^{239}Np in natural uranium metal foils irradiated in a zero-energy reactor. The foils are dissolved in nitric acid in the presence of ^{237}Np used for the determination of the yield of ^{239}Np. Neptunium is co-precipitated with lanthanum fluoride; lanthanum and thorium are removed by

anion exchange in hydrochloric acid solution, and the neptunium is further purified by anion exchange in nitric acid solution. Sources for counting are prepared by direct evaporation of an aqueous solution onto a stainless steel disc. No corrections are necessary to the ^{237}Np α-count for absorption in the source. The method does not necessitate prior separation of daughter ^{233}Pa from the ^{237}Np tracer and gives sources of high purity in good yield. (auth)

4042 DETERMINATION OF THORIUM AND URANIUM IN BIOLOGICAL MATERIALS. Picer, M.; Strohal, P. (Inst. for Medical Research, Zagreb. Inst. Ruder Boskovic, Zagrab). Anal. Chim. Acta, 40: 131-6(1968).

An activation method for the determination of traces of thorium and uranium in various biological samples after wet digestion is described. The (n,γ) and β-decay products of both thorium and uranium were separated and measured. Modified radiochemical separation procedures for protactinium and neptunium activities are described. The method was applied to the determination of thorium and uranium in urine, feces, bone, blood, water, and some chemicals. (auth)

4043 SPECTROPHOTOMETRIC DETERMINATION OF TRACES OF PHOSPHORUS BY AN EXTRACTION METHOD. Pakalns, P. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Anal. Chim. Acta, 40: 1-12(1968).

A general method is presented for the spectrophotometric determination of phosphorus at trace levels. It involves extraction of the yellow molybdophosphoric acid with isobutyl acetate and subsequent reduction to heteropoly blue. The method covers the range 0.2–20 μg of phosphorus. A comprehensive study of interferences using standard additions of 10 and 20 μg of phosphorus was carried out and modifications are described to permit the determination of phosphorus in a wide variety of metals and salts. (auth)

4044 DETERMINATION OF RARE EARTH ELEMENTS IN ROCKS AND MINERALS BY MASS SPECTROMETRIC, STABLE ISOTOPE DILUTION TECHNIQUE. Schnetzler, Charles C.; Thomas, Herman H.; Philpotts, John A. (Goddard Space Flight Center, Greenbelt, Md.). Anal. Chem., 39: 1888-90(Dec. 1967).

The method described does not require complicated chemical procedures of the standard neutron activation techniques, appears to be more precise than any of the reported techniques, and may be more accurate. Comparison data are reported. (auth)

4045 CHEMICAL ANALYSIS OF SOLIDS BY SPARK MASS SPECTROMETRY. Cormu, Ayme; Bourguillot, Robert; Stefani, Rene. Energ. Nucl. (Paris), 9: 386-93(Oct. 1967). (In French).

The testing of highly pure materials brought about new analytic techniques. Among them, spark mass spectrometry has an important place in chemical analysis of solids. The important aspects of spark mass spectrometry are: an accuracy that permits the determination of traces of elementary impurities beginning with a content of some $\gg 10^{-9}$ under good conditions and some 10^{-7} under less agreeable conditions; and the possibility of analyzing all impurities at the same time in conducting solids, even those of gases and metalloids, and in one single operation. Moreover, with special adjustments, the determination can be made on insulators, local and surface analysis can be done and organic products can be studied. (auth)

4046 CHELATOTITRATION OF RARE EARTH ELEMENTS AND YTTRIUM IN THE PRESENCE OF LARGE AMOUNTS OF MERCURY AND ALKALI EARTH ELEMENTS. Tung, Shao-tsun, Chung Kuo K'o Hsueh Yuan, Ying Yung Hua Hsueh Yen Chiu So Chi K'an, No. 16, 61-7(June 1966).

Chelatotitrations of rare earth metals and Y were performed in the pH range from 4.5 to 5.9 with hydroxyammine hydrochloride and tetramethyltetrammine as inhibitors and arsenazo I as indicator. Calcium could be tolerated to 68 times of the rare earths present and Hg, masked with thioamminoureate could be tolerated to 18 times the rare earths present. The solution remained clear and odorless, and the average error was ±0.9%. Chelatotitration could be performed on La, Ce, Nb, Sm, Yb, and Y rare earths in the presence of Ca and Hg. Large quantities of Ba, Sr, Mg, Li, and Na do not interfere with the titration. Al could be masked with sulfosalicylic acid. The permissible concentrations of Cu^{2+} was 0.1 millimole and arsenic 0.015 millimole. Other ions, Fe^{2+}, Co^{2+}, Ne^{2+}, Cd^{2+}, Pb^{2+}, Mn^{3+}, Sn^{2+}, W^{6+} and Mo^{6+}, all interfere with the titration. (JPRS)

4047 COKE MOISTURE MEASUREMENT BY MEANS OF NEUTRONS. Schwarzlose, J. Isotopenpraxis, 3: 352-8(Sept. 1967). (In German).

The technique of moisture measurement based on slowing-down of fast neutrons by light nuclei was tested in the case of coke. In principle, the applicability of the technique was stated by laboratory tests. Measurements in industry showed that in the range from 0 to 20% water the moisture of coke can be determined with an accuracy of ±0.6 to ±0.9% water, sufficient to recommend the continuous neutron technique for utilization instead of the method of manual moisture measurement. (auth)

4048 USE OF DIMETHYL SULPHOXIDE AS A SOLVENT FOR THE RAPID ISOTOPIC ANALYSIS OF WATER BY INFRARED SPECTROMETRY. Mahadevan, E. G. (Columbia Univ., New York). Analyst, 92: 717-8(1967).

Mixtures of water and deuterium oxide in dimethyl sulphoxide (solvent) were analyzed by observing O–H and O–D stretching frequencies at 1595 and 1402 cm^{-1}, respectively, with an infrared spectrometer. An accuracy of ±5% in the concentration of deuterium oxide in the range 3 to 25% v/v was obtained. The absolute percentage of deuterium oxide obtained by this infrared method agreed closely with the values obtained by using a mass-spectrometric method of analysis. (auth) (UK)

4049 METHODS OF CHEMICAL SEPARATION APPLIED TO ACTIVATION ANALYSIS. Wodkiewicz, L. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 83-91(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Application of precipitation, distillation, extraction, and ion-exchange methods of separation to activation analysis is discussed. Precipitation techniques are discussed on the basis of analysis of metallic Bi for trace amounts of Ag, As, Sb, Cu, Fe, Mn, and Na. Extraction techniques were applied to the determination of trace amounts of Au, Mo, Cu, Zn, Ga, and In in semiconductor material. As, Sb, and Sn were separated by distillation. Ion-exchange techniques were applied to the determination of rare earths in a strongly basic and ion-aqueous EDTA solution and to the determination of Ce and Rb in mineral salts. (auth)

4050 APPLICATION OF THE METHOD OF NEUTRON ACTIVATION ANALYSIS FOR INVESTIGATING THE PURITY OF VARIOUS MATERIALS. Allina, Z.; Otwinowski, W. (Inst. of General Chemistry, Warsaw). Nukleonika, 10: Suppl., 93-9 (1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

A review is presented of the work carried out to determine by neutron activation analysis Mn and Zn in metallic Bi of high purity; Mn, Cu, Zn, and As in HCl and HNO_3 of spectral purity; Cu, Zn, As, and Fe in Se of high purity; and Se in nicotinic acid. (auth)

4051 CHROMATORADIOMETRY AND ITS APPLICATION TO QUANTITATIVE MICROANALYSIS OF FATS AND CARBOHYDRATES. Budzynski, A. Z. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 101-10(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

A technique based on separation of unlabeled compounds by paper chromatography followed by direct labeling on a paper of the separated compounds located in spots is described. For labeling purposes a choice was made of such reactions as produce on a paper insoluble radioactive precipitates formed from the compound being determined and from a simple radioactive reagent. By means of the technique, called chromatoradiometry some organic and inorganic compounds essential in plant and animal metabolism were determined. Unsaturated fatty acids were determined by addition of ^{131}I to double bonds. Saturated fatty acid, some inorganic phosphates, and glucose-1-phosphate were determined by precipitation of their Ag salts and subsequent transformation into $Ag^{131}I$. Simple sugars, polyols, amino sugars, and uronic acids were treated with ammoniacal solution of $AgNO_3$ and metallic Ag deposit was converted into radioactive AgI. Quantitative calculations were based on relations between the amount of determined compound in the spot and such radiometrical parameters as: total spot activity, maximal spot activity, and spot length. Examples and perspectives of chromatoradiometry especially in biochemical research are discussed. (auth)

4052 DETERMINATION OF TRACE CONTAMINATIONS IN HIGH PURITY MATERIALS. Minczewski, Jerzy (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 157-67 (1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

The application of emission spectrography, visible spectrophotometry, and neutron activation to the determination of trace contaminations in nuclear grade U metal and its salts, Al, graph-

ite, and other reactor materials is discussed. Experimental techniques are described, and results are given. Some general remarks concerning trace analysis are given. (auth)

4053 URANIUM DETERMINATION METHODS. Rutkowski, Wladyslaw (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 169-85(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Methods elaborated or adapted for determining uranium in ores, concentrates, wastes, and other products of uranium technology are reviewed. The results of emission spectrographic, fluorescent, polarographic volumetric, and gravimetric determination methods, and extraction and chromatographic separation methods are discussed. An attempt was made to compare the advantages and disadvantages, such as reproducibility, detectability and precision, of the methods. (auth)

4054 ANALYSIS OF RARE EARTHS. Strzyzewska, B.; Radwan, Z.; Nowicka-Jankowska, T. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 309-17(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Ion-exchange methods for separation of rare earths from a U matrix are described. The final Cl^- or versenate solutions of the rare earths obtained from the separation contain 1 to 10 $\mu g/ml$ of individual rare earth elements. Two spectrographic methods were developed: one with a sifter electrode for determination of La and Y (detectability 1×10^{-1} μg in the electrode) and the second with a carrier distillation for determination of all rare earths (detectability 2×10^{-2} to 16×10^{-2} μg of the particular rare earth in the electrode). Direct spectrographic methods for determination of La, Pr, and Nd in 99.99% Ce_2O_3 and a direct spectrophotometric method for determination of Pr and Nd in 99.9% Ce_2O_3 were developed, as well as a method for determination of Al in Ce metal and trace amounts of Eu in other rare earths. Determination of rare earths by neutron activation methods was also developed with separation of the rare earths on an anion exchange resin (Amberlite IRA-400) being used for this purpose. (auth)

4055 SPECTROGRAPHIC ANALYSIS OF RADIOACTIVE MATERIALS. Fijalkowski, J. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 325-32(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

With special consideration to the excitation technique offering greatest safety to the operating personnel, the copper spark method is described for spectrographic determination of trace impurities in radioactive solutions of ^{131}I, ^{32}P, and ^{35}S. The method is satisfactory for the determination of nonradioactive materials such as P and S. Equipment for the sample preparation and excitation is described. (auth)

4056 MEASUREMENT OF THE ACTIVITY OF THE PREPARATIONS OF TRITIATED WATER BY MEANS OF A WINDOWLESS FLOWING GAS COUNTER. Lenskii, L. A. Zh. Fiz. Khim., 41: 2340-2(Sept. 1967). (In Russian).

The flowing counter of the type SOT-30-BFL can be used for the direct measurement of the activity of tritiated water samples if the temperature of the surrounding medium does not exceed 10°C. For extension of the range of satisfactory operation during activity measurements circuits standardizing output pulses of the counter and guaranteeing its constant dead time can be used; this purpose can be attained by the use of artificial quenching of the discharge or use of pulse feed of the counter. (tr-auth)

4057 METHODS OF CONCENTRATION AND DETERMINATION OF COBALT, NICKEL, COPPER, ZINC, CADMIUM, MERCURY, AND URANIUM IN AGROCHEMICAL, BIOGEOCHEMICAL, AND BIOLOGICAL INVESTIGATIONS. Malyuga, D. P.; Makarova, A. I., Makhova, N. N. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Agrokhimiya, No. 9, 139-45(Sept. 1967). (In Russian).

The method for the polarographic determination of Co, Ni, Cu, Zn, and Cd with preliminary co-oxidation of their rubeanic acids was improved. A rapid method for the concentration of U on a sodium diethyl dithiocarbamate base and luminescent determination in soils and plants was developed. The sensitivity of the method is 1.0×10^{-3}% and the precision is 5%. A method for the determination of Hg in humus soil and plants is given. It is based on the sublimation of Hg and extraction titration with dithizone in carbon tetrachloride. Rubeanic acid was used for the concentration of Hg during its determination in plants. (tr-auth)

4058 NEUTRON ACTIVATION ANALYSIS OF ^{197}Hg AND RELATED RADIOCHEMICAL SEPARATIONS. Kim, Chong Kuk. College Park, Md., Univ. of Maryland, 1966. 74p.

Thesis.

A method for the rapid, reliable high sensitivity measurement of mercury by neutron activation analysis was developed. The method was applied to the measurement of the background level of mercury in wheat. It affords the possibility of becoming a routine procedure for the Food and Drug Administration in controlling the use of mercurials in wheat. The analytical procedure is based on thermal neutron irradiation of samples, a single-step selective chemical separation of mercury, and measurement of the photons emitted by 65 hr ^{197}Hg. Sample irradiations were performed up to 3 hours in a neutron flux of 10^{11} n cm^{-2}, $second^{-1}$, 2 hours in a neutron flux of 10^{12} n cm^{-2} $second^{-1}$, and up to 20 minutes in a neutron flux of 10^{13} n cm^{-2} $second^{-1}$. The radiochemical separation is a heterogeneous exchange process between the radiomercury in an aqueous solution of the dissolved irradiated sample and a droplet of liquid mercury. The procedure for transferring the radiomercury in the solution to the liquid mercury takes less than 5 minutes. It is very selective, and no contaminants were found in the analysis. The recovery of ^{197}Hg in the separation step is 95% effective and the overall recovery of mercury in the entire analysis of wheat and tobacco samples is 90 percent. The radioactivity due to Hg was determined by gamma spectrometry. The practical sensitivity of this method with a neutron flux of 10^{13} n cm^{-2} $second^{-1}$ approaches 10^{-10} gm of mercury. The mercury content of wheat samples from twelve states and nine foreign countries was measured. Values ranged between thirty and seventy ppB. These values can now serve as a background level which public health authorities can use to determine the further introduction of mercury by the improper use of pesticides. The technique can be used to separate and measure trace quantities of noble metals such as gold and platinum. (Disser. Abstr.)

4059 REMOTELY CONTROLLED POLAROGRAPHY APPARATUS. Azoeuf, Pierre; Guillon, Andre; Rouet, Michel; Sauvagnac, Robert. (to Commissariat a l'Energie Atomique). British Patent 1,089,600. Nov. 1, 1967. Priority date Oct. 6, 1965, France.

A remotely controlled polarographic apparatus comprises a body in the form of two parts, a top and a bottom, interconnected rigidly, e.g. by screws. The top part is supported by a straddle metal support having locking means for retaining or releasing the top part and has tubular connecting means connected to passages extending without interruption in the top part and bottom part. The bottom part makes contact when it is in operative position with the solution being studied, which is received in an analysis vessel disposed in a cylindrical vessel support rigidly connected to the bottom part by a bayonet device and having a sliding foot. The tubular connecting means are used for connections to a reference cell, an inert gas supply, and a Hg supply. The source of electrical power and inert gas may be situated and controlled from outside a safety enclosure if the solution being analyzed is radioactive. (B.L.M.)

4060 CHEMICAL ANALYSIS OF RADIOACTIVE MATEiials. Lavrukhina, A. K.; Malysheva, T. V.; Pavlotskaya, F. I. London, Iliffe Books Ltd., 1967. 386p. 50s.

Translation from Russian Text Radiokhimicheskii Analiz.

The subject is treated under the following main headings: state and behavior of radioelements in solution; theoretical bases of methods of radiochemical analysis; methods of identifying radioisotopes; isolation and concentration of radioelements and methods of isolating individual elements in radioactively pure state. (UK)

4061 IMPROVEMENTS IN AND RELATING TO BENCHES FOR TAKING SAMPLES OF LIQUIDS AND IN PARTICULAR RADIOACTIVE LIQUIDS. (to Commissariat a l'Energie Atomique). British Patent 1,087,953. Oct. 18, 1967. Priority date Apr. 20, 1964, France.

A bench for taking liquid samples, particularly radioactive samples, contained in a number of chambers located under the working plane of the bench is described. The sample is put into a bottle or container in which a vacuum was created through a selected one of a number of hollow needles, each one of which is adapted to extend into one of the chambers. The bench also includes a glove box having a base that comprises the end element of the needles. The centers of the ends of the end elements are located on at least one circumferential arc. A support is located above the end elements and is rotatable about a first axis. Within the support is a rotatable tool carrier movable about a second axis different from the first axis. A number of tools to be employed in succession for taking samples are located in the tool carrier in eccentric positions in parallel relation to the second axis and at equal distances from it. (B.L.M.)

4062 IMPROVEMENTS IN METHODS AND APPARATUS FOR DETERMINING THE AMOUNT OF HYDROGEN DISSOLVED IN A FLUID. Gabilly, Roger; Vignet, Paul; Zermizoglou, Roger

(to Commissariat a l'Energie Atomique). British Patent 1,089,831. Nov. 8, 1967. Priority date Aug. 5, 1964, France.

A method for the determination of either light or heavy hydrogen dissolved in a fluid comprises passing the stream of the fluid along with O_2 at a concentration by volume higher than half the estimated maximum amount of H_2 to be determined into a container where the O_2 and H_2 are reacted in the presence of a suitable catalyst and continuously measuring the amount of O_2 present in the inlet and outlet fluid stream. Thus at any time the amount of O_2 that has combined with the H_2 in the container can be measured, and the corresponding amount of H_2 and the H_2 concentration by volume can be calculated. (B.L.M.)

4063 RADIOMETRIC FILM. Withnell, R. (to U. S. Atomic Energy Commission). U. S. Patent 3,356,530. Dec. 5, 1967.

A thin 4π source-carrier film and method for making it for use in radiometric measurements are described. The film has an electrically conducting coating with high infrared light transmission to provide a durable film on which a radioactive solution can be placed and quickly dried. (AEC)

4064 RARE-EARTH ELEMENTS IN BASIC AND ULTRABASIC ROCKS. Frey, Frederick August. Madison, Wis., Univ. of Wisconsin, 1967. 435p.

Thesis.

Neutron activation analysis was used to determine rare-earth elements in several types of terrestrial rocks. Analysis of composite granites and sediments indicate that the upper crust is relatively enriched in the light lanthanides. Chondrites are often regarded as samples of matter which are the least differentiated from primordial solar system material. If the earth as a whole has a chondritic relative rare earth element distribution, there must be terrestrial rocks which have light rare earth depleted distributions. In general, the lanthanide abundances in basic and ultrabasic rocks provide data which can be used as an additional criterion in the evaluation of geologic hypotheses. The rare earth element data do not provide definite proof because the variables controlling lanthanide abundances, and distributions are not fully understood. (TSS)

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Refer also to abstracts 4190, 4225, 4803, 4847, 4869, 4881–4883, 4891, 4897, 5417, 5418, and 5486.

4065 (ANL–7167) KINETICS OF THE TITANIUM–NITROGEN REACTION WITH APPLICATION TO THE DESIGN OF GETTERING SYSTEMS. Kyle, M. L.; Coleman, L. F.; Pierce, R. D.; Arntzen, J. D. (Argonne National Lab., Ill.). Apr. 1967. Contract W-31-109-eng-38. 34p. Dep. CFSTI.

The rate of reaction between titanium-metal sponge and nitrogen in argon–nitrogen mixtures was studied at 900°C. The reaction rate depends upon the partial pressure of nitrogen in the gas phase. At least three titanium-nitrogen solid phases are formed as the reaction proceeds, and the rate-controlling mechanism is believed to be the diffusion rate of atomic nitrogen through the TiN_x (δ) phase. Early reaction kinetics can be described by the conventional parabolic relationship, but this relationship is not valid for extended periods of time. A single relation has been developed which satisfactorily describes the reaction kinetics at nitrogen partial pressures from 100 to 50,000 ppM (by volume) and times to 1000 hr. Additional mathematical relationships have been developed to permit the design of titanium gettering systems for the removal of nitrogen from argon. These relationships apply to the following operating conditions: nitrogen concentrations in argon from 50 to 50,000 ppM; a reacting temperature of 900°C; total pressure near 1 atm; titanium-metal sponge of a surface area near 800 cm^2/g; and low (~1 ppM) oxygen and water content of the gas. Under these conditions, the relations presented should permit the design of a gettering system with an uncertainty of about ±10% in the required bed size and useful life. (auth)

4066 (COO–1354-13) TECHNICAL PROGRESS REPORT [ON GELS]. [Maatman, Russell] (Dordt Coll., Sioux Center, Iowa). Nov. 1, 1967. Contract AT(11-1)-1354. 5p. Dep. CFSTI.

Developments are reported for studies on: reactions of aqueous salts with chromia–alumina; behavior of aqueous solutions of salts in the pores of high-surface-area carbon; reactions between aqueous Ni^{2+} and high-surface-area alumina and the nickel–alumina catalyst; reactions between aqueous platinum and high-surface-area alumina and the platinum–alumina catalyst; and reactions of inert-gas-type ions with alumina, and the relation between this reaction and the catalytic properties of alumina. (P.C.H.)

4067 (IS-T–208) DEPENDENCE OF THE THULIUM AND NEODYMIUM 2-HYDROXYISOBUTYRATES STEP-FORMATION CONSTANTS ON IONIC STRENGTH. Matkovich, Maureen Welling (Ames Lab., Iowa). Nov. 1967. Contract W-7405-eng-82. 56p. Dep. CFSTI.

Thesis.

The stoichiometric step-formation constants of the neodymium and thulium 2-hydroxyisobutyrate (2-methyllactate) complexes were determined at 25°C and at ionic strengths from 0.05 to 0.70, by a potentiometric method. The ionic strength was adjusted with KNO_3. The ratio of the first and second step-formation constants was determined at each ionic strength. The ratio was found to decrease exponentially with the increasing square root of ionic strength. The thermodynamic ratio of the first and second constants was extrapolated by a least squares technique. From the thermodynamic ratio and with the use of a coulombic factor, it is proposed that the 2-hydroxyisobutyrate anion bonds tridentately to the larger rare earth cations and bidentately to the smaller rare earth cations. (auth)

4068 (NSRDS-NBS–7) HIGH-TEMPERATURE PROPERTIES AND DECOMPOSITION OF INORGANIC SALTS. PART 1. SULFATES. Stern, K. H.; Weise, E. L. (National Bureau of Standards, Washington, D. C.). Oct. 1, 1966. 38p. GPO $0.35.

Literature dealing with the high-temperature behavior of inorganic sulfates was critically reviewed. Free energy functions of reactants and products of the decomposition reactions were calculated and tabulated from 298°K up to as high a temperature as possible. Free energy functions, equilibrium constants of reactions, and partial pressures of gaseous components were tabulated. Auxiliary data on phase transitions, densities, and kinetics of chemical decomposition were included. (auth)

4069 (ORNL–TM–2037) PRESENT COSTS OF AMINO ACIDS AND A PROPOSAL FOR THEIR PRODUCTION IN AN ARGO-INDUSTRIAL COMPLEX. Davis, W. Jr. (Oak Ridge National Lab., Tenn.). Nov. 6, 1967. Contract W-7405-eng-26. 11p. Dep. CFSTI.

Of the 20 amino acids that are essential to, or usable in, human nourishment, all can be made by wholly-chemical methods that are described in the literature. Present costs and production rates of these acids are summarized. At present, arginine, glutamic acid, histidine, and tryptophan are usually produced from biologically-derived materials, such as gelatin, wheat gluten, blood proteins, and casein, respectively. It is suggested that the manufacture of all amino acids, essential and nonessential, should be examined as a unit of Agro–Industrial Complexes associated with dual-purpose power-desalination reactors. (auth)

4070 (UR–49–866) A STUDY OF THE CRYSTALLIZATION OF THE DISODIUM, DIBARIUM, AND MAGNESIUM SALTS OF ADENOSINE TRIPHOSPHATE. Lian, Jane Barbara (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). Nov. 30, 1967. Contract W-7401-eng-49. 50p. Dep. CFSTI.

Thesis.

The disodium salt of adenosine triphosphate (ATP) was crystallized from aqueous solutions under various conditions by addition of either ethanol, isopropanol, n-propanol, tert-butyl alcohol, ethylene or propylene glycol, dimethysulfoxide (DMSO), and tetrahydrofuran (THF) or acetonitrile. The crystallization of Na_2H_2ATP was undertaken to obtain crystals suitable for x-ray diffraction. It was also hoped that a general procedure for crystallizing tripolyphosphates could be developed. The attempted crystallization of the magnesium salt of ATP is also described. Since the Mg-ATP was prepared from the dibarium salt of ATP, the Ba_2ATP-solvent system was also studied. Barium and magnesium ATP complexes could not be crystallized either following the procedure used for the crystallization of the sodium ATP or by the other techniques tried. The effects of the solvents and conditions of temperature, pH, and concentration on the crystallization and the stability of the Na_2H_2ATP crystals are discussed. (auth)

4071 (ANL-Trans–539) TERNARY OXIDES OF 3-7-VALENT TECHNETIUM WITH ALKALIES. Kanellakopulos, Basil (Kernforschungszentrum, Karlsruhe (West Germany)). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report KFK–197. 69p. Dep. CFSTI. JCL $6.60 fs, $2.27 mf.

The system Li–Tc–O and Na–Tc–O were investigated by chemical and radiographic methods. Several compounds of the type Me^1TcO_4(Me^1 = NH_4, Li, Na, K, Cs, Rb, Ag, Tl) were prepared. $CsTcO_4$ and $TlTcO_4$ exhibited an orthorhombic structure whereas all the other possess a scheelite structure. Li_4TcO_5 and Li_4TcO_5 could be obtained in two modifications in the system TcO_3–Li_2O. No formation of a compound could be observed in the

system TcO_3-Na_2O. Li_3TcO_4 was prepared in the system $Tc_2O_5-Li_2O$ with two modifications. $NaTcO_3$ was obtained in the system $Tc_2O_5-Na_2O$. Li_2TcO_3 could be obtained in the system TcO_2-LiO. Both Na_2TcO_3 and Na_4TcO_4 could be prepared in the system TcO_2-Na_2O. All experiments on the preparation of $LiTcO_2$ in the system $Tc_2O_5-Li_2O$ were unsuccessful. A ternary oxide of the composition $NaTcO_2$ could be obtained in the system $Tc_2O_5-Na_2O$. (M.C.G.)

4072 (JPRS-43026) SOLUBILITY OF URANIUM TETRAFLUORIDE IN ALUMINUM SALT SOLUTIONS. Vdovenko, V. M.; Romanov, G. A. Translated from Radiokhimiya, 9: 384-6 (1967). 5p. (TT-67-33651). CFSTI.

On the basis of data on the solubility of uranium tetrafluoride in $Al(ClO_4)_3$ solutions and the absorption spectra of these solutions it was concluded that in the systems studied the $U^{(IV)}$ is found in the form of complex UF_3^{3+} ions. The solubility of UF_4 was studied in solutions containing hydrated ions of tetravalent uranium. It is shown that the complex UF_3^{3+} forms when UF_4 is dissolved. (auth)

4073 LA-tr-67-109) INSOLUBILIZATION OF POLYVINYLFURAN. Nakamura, Y.; Saito, M. Translated for Los Alamos Scientific Lab., N. Mex., from Kogyo Kagaku Zasshi, 62: 1168-72(1959). 20p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Insolubilization of poly(vinylfuran) was studied by investigating chemical changes in the insolubilization process using infrared and uv absorption spectra and chemical analysis. Kinetics of the insolubilization were also investigated. In the presence of oxygen, 2-vinylfuran polymerized at a relatively low temperature and the resulting polymer contained peroxides. Decomposition of the peroxides also caused partial decomposition of the furan ring in the polymer and mutual condensation of the decomposition product resulted in a cross-linked structure which was responsible for the polymer insolubilization. Therefore, insolubilization of poly(vinylfuran) (the heat of activation for the reaction, E = 35.1 kcal $mole^{-1}$) by heating was postulated to consist of three reaction steps, namely: decomposition of peroxide in the polymer (E = 10.7 kcal $mole^{-1}$); decomposition of the furan ring by oxygen (E = 6.4 kcal $mole^{-1}$); and mutual condensation of the decomposition product (E = 13.1 kcal $mole^{-1}$). Insolubilization of relatively pure poly(vinylfuran) at room temperature in the atmosphere or by heating (E = 22.2 kcal $mole^{-1}$) consisted of the last two reaction steps. Moreover, the structure of poly(vinylfuran) insolubilized in the presence of a strong acid was found to be caused by decomposition of the furan ring and subsequent mutual condensation of the decomposition product. The heat of activation for the insolubilization by acid was estimated to be 17.7 kcal $mole^{-1}$. Therefore, the reaction mechanism of insolubilization by acid was presumably different from that by oxygen. (auth)

4074 KINETICS OF THE FLUORINATION OF BERYLLIUM. O'Donnell, Patricia M. (Lewis Research Center, Cleveland). J. Electrochem. Soc., 114: 1206-9(Dec. 1967).

The kinetics of the reaction of sheet beryllium and gaseous fluorine to form beryllium fluoride were studied by means of the pressure-drop method over the temperature range from 125 to 775°C and at pressures from 20 to 700 Torr. The reaction followed the parabolic rate law. Parabolic rate constants were calculated, and activation energies are given. The pressure dependence is approximately first order with respect to the fluorine pressure. A change of slope in the plot of the rate constant against reciprocal temperature suggests a change in the nature of the reaction near 525°C. Above 525°C the crystal structure of the film changes from α-quartz hexagonal to rhombic tridymite. Beryllium is identified as the diffusing species. (auth)

4075 MANIFESTATION OF INTRAMOLECULAR VIBRATIONS IN LUMINESCENCE SPECTRA OF URANYL COMPOUNDS. Volodko, L. V.; Sevchenko, A. N.; Umreiko, D. S. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 46-8(July 1967).

Translated from Opt. Spektrosk., 23: 89-95(July 1967).

The luminescence spectra of a number of crystalline complex compounds of uranyl nitrate and uranyl acetate with organic addends were investigated. The lines of the fluorescence spectra are interpreted on the basis of a comparison with the ir absorption spectra and the Raman spectra. The manifestation of a donor-acceptor coupling in these spectra is established, as is the interaction between the electron shells of different component parts of the complex. (auth)

4076 ROENTGENOLUMINESCENCE OF $CaSO_4$-Mn-PHOSPHOR AND ITS ACCUMULATION CAPACITY. Ivanity, G. M. (Dnepropetrovsk State Univ., USSR). Ukr. Fiz. Zh., 12: 1206-8(July 1967). (In Russian).

Although the thermoluminescence of $CaSO_4$ phosphors has been well studied, the processes occurring at the time of the irradiation are still not known. Therefore, this problem was investigated by examining the roentgenoluminescence, thermoluminescence, and the afterglow of powdered $CaSO_4$-4 mole % Mn specimens, prepared by sintering the mixture at 900 to 1000°C. The three types of light emissions were found to be identical, containing a single, temperature-independent emission band at $\lambda = 500$ mμ. The burnout period of the roentgenoluminescence at room temperature was found to be quite long; it increased with the intensity of irradiation and could reach 3 to 4 hr. It decreased with the temperature and above 200°C it amounted to only a few seconds, indicating temperature quenching. The brilliance, B_{rl}, followed an exponential function: $B_{rl} = B_{st}(1 - e^{-\alpha t})$, whereby the value of α may range from 0.1 to 10^{-4} sec^{-1}, B_{st} is the stationary value of brilliance, and t is the time of irradiation. The light stored in the phosphor during irradiation and the subsequent release during the afterglow and upon heating was determined from the areas lying below the luminescence burnout, afterglow, and thermoluminescence curves; these areas were used to estimate the storage capacity of the phosphor. The $CaSO_4$-Mn phosphor was found to possess a large storage capacity. (TTT)

4077 H/D EXCHANGE IN N,N-DIMETHYLFORMAMIDE ACETALS AND ORTHOFORMIC ESTERS. Simchen, G.; Rebsdat, S.; Kantlehner, W. (Technische Hochschule, Stuttgart). Angew. Chem. Int. Ed. Engl., 6: 875(Oct. 1967).

When dissolved in deuterioalcohols, most N,N-dialkylformamide acetals exchange their formyl proton for deuterium within a few minutes. The rate of exchange depends on the acidity of the alcohol used. (M.C.G.)

4078 PHYSICAL PROPERTIES OF NIOBIUM AND TANTALUM NITRIDES. Verkhoglyadova, T. S.; L'vov, S. N.; Nemchenko, V. F.; Samsonov, G. V. (Kherson State Pedagogical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 8, 31-4 (1967). (In Russian).

Experimental data on the microhardness, electric conductivity, thermal conductivity, Hall coefficient, and thermoelectromotive force of tantalum and niobium nitrides are reported. On the basis of the data obtained, the electron structure of the compounds and their phase composition are qualitatively discussed. The variation of the investigated properties with increase in nitrogen content in both systems proceeded identically: with small nitrogen content the electroconductivity was principally hole conductivity but with nitrogen contents over ~26 at. % it was electron conductivity. (tr-auth)

4079 THERMOMETRIC STUDY OF THE FORMATION OF LANTHANIDE CITRATE AND TARTRATE COMPLEXES. Gallet, Jean-Pierre; Paris, Rene A. (Univ., Lyon). Anal. Chim. Acta, 40: 321-7(Feb. 1968). (In French).

Thermometric measurements make it possible to detect all citrate and tartrate complexes of lanthanides on only one enthalpogram. A suitable gradient of pH must be chosen in order to allow the successive formation of the complexes. (auth)

4080 STUDIES ON THE REDUCTION OF THORIA BY CALCIUM. Takeuchi, Sakae; Honma, Toshio; Satow, Tsuneo; Sonoda, Susumu; Kawai, Hiroshi; Koyama, Keiji. Nippon Kinzoku Gakkaishi, 31: 42-8(1967). (In Japanese).

Various experiments for the reduction of ThO_2 by Ca were performed to determine the most industrially favorable condition for preparing Th metal. Stainless steel having no surface lining was the most suitable material for a reactor vessel, while the yield deteriorated in the case of a graphite reactor vessel. The optimum particle size of ThO_2 was about 150 μ. A high yield of metal could be obtained by using $CaCl_2$ flux of 20 to 40% for the weight of ThO_2 and about 25% in excess of the theoretical amount of Ca. The efficiency of reduction was highest on heating for 4 hr at 950°C or for 3 hr at 1050°C. Under the above-mentioned conditions, about 90% yield of Th metal and 3 to 7% of residue, undissolved with HCl, could be obtained. (Rev. Met. Lit.)

4081 REACTIONS OF COMPOUNDS IN THE Nb-C-O SYSTEM WITH CO OR CO_2. Kimura, Hirozo; Sasaki, Yasuo; Uehara, Shigeaki. Nippon Kinzoku Gakkaishi, 31: 395-400 (Apr. 1967). (In Japanese).

Reactions of solid phases, such as Nb, NbO, NbC, and Nb_2O_5, with CO, CO_2, or a mixture of CO and CO_2, to 1400°C, were studied by the measurement of weight changes, x-ray analysis, and chemical analysis. In the reactions of Nb or NbO with CO, mixtures of NbO_2 and NbC were obtained as final products. Carbon and O_2 increased during the arc melting process in CO atmosphere in the specimen containing more than 80 at. % Nb. Carbon and O_2 were found to decrease in most specimens during the arc melting process in CO or Ar atmosphere, and the rate of decrease was remarkable in the specimens containing O_2 and C at the ratio of about 1:1. (Rev. Met. Lit.)

4082 COMPARISON OF CHEMICAL FLOW REACTOR RESIDENCE-TIME DISTRIBUTIONS WITH RADIOTRACER TECHNIQUES. Mullen, R. T.; Grabner, R. W.; Kaufman, A.; Reich, A. R. (Merck and Co., Inc., Rahway, N. J.). Trans. Amer. Nucl. Soc., 10: 455(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4083 THRESHOLD PRESSURES FOR THE REACTION OF SODIUM AND OTHER ALKALI METALS WITH GRAPHITE. Salzano, F. J.; Aronson, S. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 493-4(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4084 CORRELATION OF SOLUBILITY DATA FOR HYDROGEN AND NITROGEN IN WATER. Andersen, Theodore S. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 507-8(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4085 CRYSTALLIZATION CHARACTERISTICS OF ACIDIC URANYL NITRATE SOLUTIONS. Kispert, R. C.; Cavendish, J. H.; Leist, N. R. (National Lead Co. of Ohio, Cincinnati). Trans. Amer. Nucl. Soc., 10: 540-1(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4086 MACROPOROUS PHOSPHONIC RESINS. Nikolaev, A. V.; Gribanova, I. N.; Khol'kina, I. D.; Yakovleva, N. I. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 7, Ser. Khim. Nauk, No. 3, 86-90(May 1967). (In Russian).

The preparation and properties of macroporous phosphonic resins are described. The resins are styrene–divinylbenzene copolymers and contain phosphonic groups RP (=O)$(OH)_2$. Exchange of the cations Na^+ and UO_2^{2+} was studied on the phosphonic resins. It was found that the resins are characterized by high exchange rate and diffusion extent for $UO_2(NO_3)_2$. (auth)

4087 EXTRACTION OF SOME ELEMENTS BY ALIPHATIC MONOCARBOXYLIC ACIDS. CATION-EXCHANGE EXTRACTION SERIES. Gindin, L. M.; Fedyashina, A. F.; Yudelevich, I. G.; Artyukhin, P. I. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 7, Ser. Khim. Nauk, No. 3, 95-9(May 1967). (In Russian).

Extraction of Ti(III), Sn(II), Ga(III), Cr(III), In(III), Ce(III), Y(III), La(III), Ca(II), and Ba(II) by aliphatic monocarboxylic acids of the C_7 to C_9 fraction was investigated. Twenty-eight cations are arranged according to their behavior in the cation-exchange extraction series. Placement of the cation in the series depends mainly on basic properties of the metal and on the hydration energy of the corresponding cation. The effects of the extracted cation concentration and of the ionic power of the aqueous solution were studied and are discussed. (auth)

4088 THE TEMPERATURE DEPENDENCE OF THE THERMAL CONDUCTIVITIES OF GASEOUS NORMAL- AND ORTHO-DEUTERIUM AT TEMPERATURES OF LIQUID HYDROGEN. Uebelhack, W.; Eichenauer, W.; Heinzinger, K.; Klemm, A. (Max-Planck-Institut fuer Chemie, Mainz. Technische Hochschule, Darmstadt). Z. Naturforsch., 22a: 1528-31(Oct. 1967). (In German).

The relative difference of the thermal conductivities of gaseous ortho- and normal-deuterium was measured at three different temperatures: 18.5, 19.8, and 21.1°K. The results are 0.97×10^{-3}, 1.08×10^{-3}, and 1.45×10^{-3}, respectively, with an accuracy of ±10%. They are compared with the relative difference of the viscosities for the two deuterium modifications. This comparison leads to a difference in f_{tr} and f_{int} for ortho- and normal-deuterium in the Eucken relation. (auth)

4089 PROTON RELAXATION TIMES IN ^{7}LiCl AND ^{6}LiCl SOLUTIONS. Fabricand, Burton P.; Goldberg, Sigmund S. (Columbia Univ., New York). Contract Nonr-266(84). Mol. Phys., 13: 323-30(1967).

Measurements of the proton spin-lattice relaxation times were made as a function of concentration and temperature in aqueous solutions of ^{7}LiCl and ^{6}LiCl. The difference in the relaxation times for two isotopic solutions of the same concentration and temperature was found to be small, corresponding to a difference in reciprocal relaxation times of 0.004 sec^{-1}.c at 25°C, where c is the molarity of the solutions. This value decreases with increasing temperature. It is shown that the difference in relaxation times arises solely from the magnetic dipole interaction between the ^{7}Li ion nucleus and water protons. The concept of a long-lived, rigid, hydrated complex around the Li ion is shown to be inconsistent with the results. (auth) (UK)

4090 URANIUM(VI) COMPLEXES OF 8-HYDROXYQUINOLINE AND DERIVATIVES. Corsini, A.; Abraham, J.; Thompson, M. (McMaster Univ., Hamilton, Ont.). Chem. Commun., No. 21, 1101-3(1967).

Location of the acidic proton in the complex $UO_2(C_9H_6NO)_2 \cdot C_9H_6NOH$ is reported, together with a series of new U(VI) complexes of 8-hydroxyquinoline derivatives, and a method involving (^{14}C)-8-hydroxyquinoline for investigating the nature of addition complexes. Infrared spectra leave little doubt that the acidic proton is located on the ring nitrogen of the unidentate ligand and is H-bonded. The H-bond must involve the phenolate oxygen of the neighboring bidentate ligand, to which the proton makes a very close approach. Intermolecular H-bonding cannot occur. A number of 5-substituted derivatives of 8-hydroxyquinoline (Me, Ph, acetyl, Cl, NO_2) were also found to yield 1:3 complexes with U(VI), and absorption bands characteristic of the H-bonded $> NH^+$ were present in the infrared spectra. On the other hand, 7-substituted derivatives yielded complexes in which the extra liqand was replaced by H_2O, NH_3, or acetone, depending on the conditions of preparation; the $> NH^+$ bands were absent from the spectra of these compounds. It is considered that failure of the 7-substituted derivatives to yield 1:3 complexes is due to steric repulsion between (i) the $>NH^+$ proton and the 7-substituent of the neighboring bidentate ligand, (ii) the α-proton of the monodentate ligand and the 7-substituent of the monodentate ligand and the α-proton of the neighboring ligand. As a result of these repulsions smaller coordinating species present in solution can replace the extra reagent molecule. It was found that when $UO_2(C_9H_6ON)_2$ was treated with a dichloroethane solution of (^{14}C)-8-hydroxyquinoline addition of the extra ligand occurred with a yield approaching 100%, and studies indicated that the additional reagent molecule was not equivalent to the two bidentate ligands, and that the 1:3 compound is a molecular entity. (UK)

4091 STUDY OF EXTRACTION KINETICS WITH A CHEMICAL REACTION CONTROLLED BY DIFFUSION. Tinturier, Bernard; Kikindai, Tivadar (Laboratoire de Chimie Nucleaire Appliquee, Paris). Compt. Rend., Ser. C, 265: 4177-20(Aug. 16, 1967). (In French).

The dissolution by acids of hydrated uranium trioxide verifies the kinetic law established in the case of a solid–liquid reaction controlled by diffusion. Experiments have led to the determination of the diffusion coefficients of uranyl nitrate, sulfate, and chloride. (tr-auth)

4092 SORPTION CHARACTERISTICS OF MACROPOROUS PHOSPHONIC RESINS Nikolaev, A. V.; Gribanova, I. N.; Khol'kina, I. D.; Yakovleva, N. I. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 7, Ser. Khim. Nauk, No. 3, 91-3(May 1967). (In Russian).

The effect of porosity on the extent and rate of the ion exchange of $UO_2(NO_3)_2$ on macroporous phosphonic resins is described. The value of the phosphonic resin porosity was calculated from the weight volume ratio of styrene–divinylbenzene copolymers. (auth)

4093 SECONDARY ISOTOPIC EFFECT ON THE OXIDATION OF 1-^{3}H ETHANOL BY YEAST ALCOHOL DEHYDROGENASE. Biellmann, J. F.; Schuber, F. (CNRS, Strasbourg). Bull. Soc. Chim. Fr., No. 9, 3543(Sept. 1967). (In French).

The rate of oxidation of (S)-ethanol-1-^{3}H by yeast alcohol dehydrogenase is diminished by a secondary kinetic isotope effect. (auth)

4094 INVESTIGATION OF THE COMPLEX FORMATION OF THORIUM(IV) WITH N-BENZOYLPHENYLHYDROXYLAMINE BY THE DISTRIBUTION METHOD. Zharovskii, F. G.; Ostrovskaya, M. S.; Sukhomlin, R. I. Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol., 10: 989-93(1967). (In Russian).

The extraction of thorium N-benzoylphenylhydroxylaminate with chloroform (benzene) was investigated in relation to the thorium concentration, pH, and concentration of reagents in the organic phase. The thorium is extracted in the form of $Th(C_{13}H_{10}O_2N)_4$, the total formation constant of which is 5.0×10^{27}. The distribution constant between the chloroform and water is ~2000. The formation constants of the intermediate complexes, formed in the aqueous phase, were obtained. The values obtained for the constants of the complex formation, obtained on the basis of the photometric determination of the distribution coefficients, agreed satisfactorily with the analogous values obtained by radiochemical methods. (tr-auth)

4095 ELECTROLYTE COAGULATION AND STABILITY OF AQUOSOL OF Sb_2S_3 AND ITS VAN DER WAALS ATTRACTION

CONSTANT. Daluja, K. L.; Srivastava, S. N. (Agra Coll., India). Indian J. Chem., 5: 262-6(June 1967).

Quantitative study of the coagulation of negative Sb_2S_3 aquosol in the presence of a few mono-, bi-, tri- and tetravalent cations, viz. Na^+, K^+, UO_2^{2+}, Mn^{2+}, Ba^{2+}, Al^{3+}, and Th^{4+} was made by measuring colorimetrically the turbidity changes at different intervals of time. The flocculation powers of different cations acertained from these measurements are in the order $Al^{3+} > Ba^{2+} > Mn^{2+} > Th^{4+} > UO_2^{2+} > K^+ > Na^+$. There is a marked deviation from the Schulz–Hardy rule particularly for Th^{4+}, which may be due to its hydrolysis in the pH range of 3 to 4. Zeta potential of the disperse particles were evaluated electrophoretically. With these two sets of data quantitative interpretation of the result was made using the DVO theory and assuming that Stern potential is identical with zeta potential to the first approximation. The rate constants (K_0) for rapid coagulation were calculated from the experimental curves of log W (W, stability factor) versus log Ce (Ce, molar electrolyte conc.). The observed K_0 values are lower than the theoretical values probably due to the fact that the coagulated particles carry appreciable residual potential and are still associated with some electrical barrier, which is responsible for low rate constants. From the plots of log W versus log Ce the van der Waals constant (A) and Stern potential ψ_δ were calculated. The experimental values of A obtained in the presence of different cations are in excellent agreement with the calculated values. (auth)

4096 PREPARATION OF URANIUM(IV) OXYFLUORIDE. Satpathy, K. C. (M. P. C. Coll., Baripada, India); Sahoo, B. Indian J. Chem., 5: 278(June 1967).

The different hydrated forms of uranium(IV) oxyfluoride, viz. $UOF_2 \cdot 2H_2O$ and $UOF_2 \cdot H_2O$ were prepared for the first time. The oxyfluoride $UOF_2 \cdot 2H_2O$ was obtained when an intimate mixture of uranyl formate and hydrazine hydrofluoride in equimolecular quantities were heated in vacuum at 250°C. The hydrated $UOF_2 \cdot H_2O$ was obtained by the photolysis of aqueous solution containing equimolecular amounts of uranyl formate and hydrazine fluoride. The compounds are crystalline, green colored and insoluble in water. (auth)

4097 FRACTIONAL SUBLIMATION OF THE beta-DIKETONE CHELATES OF THE LANTHANIDE AND RELATED ELEMENTS. Berg, Eugene W.; Acosta, J. Jaime Chiang (Louisiana State Univ., Baton Rouge). Anal. Chim. Acta, 40: 101-13 (1968).

Various β-diketone chelates of Sc(III), Y(III), Th(IV), U(IV), U(VI), Zr(IV), and the lanthanides were prepared, characterized, and investigated to determine their volatility and stability. The ligands employed were acetylacetone(AA), trifluoroacetylacetone-(TFAA), hexafluoroacetylacetone(HFAA), and dipivaloylmethane-(DPM). The chelates were sublimed in a fractional vacuum sublimator and the recrystallization temperature zones recorded for individual chelates. None of the lanthanide acetylacetonates were volatile but the Sc(III), Th(IV), U(IV) and dioxouranium(VI) acetylacetonates were thermally stable and quite volatile below 150° at 1 mm mercury pressure. The lanthanide, Sc(III), Y(III), and dioxouranium(VI) trifluoroacetylacetonates were volatile and could be vacuum-sublimed below 150°, but were thermally unstable; only the Th(IV) chelate was sufficiently stable to be quantitatively recovered by sublimation. The Sc(III), Y(III), Th(IV), and lanthanide hexafluoroacetylacetonates were thermally stable and easily sublimed below 125° in vacuo or at atmospheric pressure. All the dipivaloylmethanates studied were thermally stable and volatile and could be quantitatively recovered by vacuum sublimation below 140°. The volatility of the HFAA and DPM lanthanide chelates increased with an increase in atomic weight (a decrease in ionic radii) of the lanthanides. The lack of volatility observed for the lanthanide AA and TFAA chelates was attributed to the fact that only hydrates of the chelates were formed, which decomposed at elevated temperatures in vacuo to form basic polymeric compounds. Separations are proposed for numerous binary mixtures of the β-diketone chelates of the lanthanide and related elements. Recrystallization temperature zones are given for the following binary mixtures which were quantitatively resolved by the fractional sublimation technique: 118 to 88° for Nd $(DPM)_3$ and 84 to 48° for $Tm(DPM)_3$; 72 to 49° for Sc(DPM) and 120 to 88° for Pr(DPM); 128 to 79° for $La(DPM)_3$ and 79 to 47° for $Yb(DPM)_3$; 70 to 47° for $Th(TFAA)_4$ and 116 to 96° for $Gd(TFAA)_3$; 52 to 42° for $Th(HFAA)_4$ and 120 to 80° for $La(HFAA)_3$. (auth)

4098 STUDIES OF THE Eu_2O_3–Ta_2O_5 SYSTEM WITH SMALL CONTENT OF Eu_2O_3. Pinaeva, M. M.; Krylov, E. I.; Ryakov, V. M. (Leningrad Technological Inst.). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1612-14(Sept. 1967). (In Russian).

The Eu_2O_3–Ta_2O_5 system with 0.1, 0.3, 1, 3, 8, and 15 mole % Eu_2O_3 was investigated and the phase diagram was constructed. The absolute maximum of the luminescence, caused by the existence of polytantalate in the system with the oxide ratio Eu_2O_3: Ta_2O_5 equal to 1:5 or 1:6, was established. It was found that the polytantalate at 1350 to 1400°C undergoes decomposition to α–Ta_2O_5 and metatantalate. (tr-auth)

4099 STUDY OF THE ELECTRIC AND MAGNETIC PROPERTIES OF ZIRCONIUM HYDRIDE. Andrievskii, R. A.; Boiko, E. B.; Ioffe, R. B. Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1591-6(Sept. 1967). (In Russian).

The electric resistance and the Hall constant increased with decrease in the concentration of hydrogen in the homogeneity range of ϵ-zirconium hydride. The magnetic susceptibility changed insignificantly. For δ hydride there was characteristic decrease of the constant R and ρ and increase of χ with decrease in the quantity of hydrogen. At the boundary of the homogeneity ranges of the δ and ϵ phases the microhardness remained approximately constant. The concentration and mobility of the current carrier (electrons) were evaluated for stoichiometric zirconium hydride. (tr-auth)

4100 PHASE DIAGRAM OF THE Ce–Te SYSTEM. Chukalin, V. I.; Yarembash, E. I.; Vilenskii, A. I. (Inst. of General and Inorganic Chemistry, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1538-45(Sept. 1967). (In Russian).

The phase diagram of the Ce–Te system was constructed on the basis of differential thermal, microstructure, and x-ray analyses. The formation of the following cerium tellurides was established: CeTe, Ce_3Te_4, Ce_2Te_3, Ce_4Te_7, Ce_2Te_5, and $CeTe_3$, and the compounds Ce_4Te_7 and Ce_2Te_5 were detected for first time. Ce_4Te_7 has a tetragonal lattice with the constants a = 8.988 and c = 9.167 Å. It belongs to the space group P4/mbm. Ce_2Te_5 apparently has the pseudotetragonal lattice with the constants a = 4.42 and c = 44.35 Å. It belongs to the space group Bmmb. It was established that the compounds Ce_4Te_7, $CeTe_2$, Ce_2Te_5, and $CeTe_3$ were formed in peritectic reactions at temperatures of 1340, 1250, 875, and 825°C, respectively. The compounds CeTe and Ce_3Te_4 are fused congruently at temperatures of 1820 and 1645°C, respectively. Assumptions were made on the formation of phases with the general formula Ce_4Te_{11}. (tr-auth)

4101 CHEMICAL REACTIONS OF TITANIUM HYDROXIDES AND LANTHANUM HYDROXIDES. Sarkisov, E. S.; Berdnikov, V. R.; Golovina, G. P. (Moscow Inst. of Fine Chemical Technology). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1627-31(Sept. 1967). (In Russian).

The quantitative yield of $La_2Ti_2O_7$ was attained by annealing precipitated hydroxides of lanthanum and titanium together at 1100°C for 1 hr. By the method of differential-thermal and x-ray analyses it was found that lanthanum titanate by the method proposed can be explained by the formation of chemical compounds in co-precipitation processes. (tr-auth)

4102 HYDRAZINIUM(+2) AND HYDROXYLAMMONIUM HEXAFLUOROURANATES(V). Frlec, Boris; Hyman, Herbert, H. (Argonne National Lab., Ill.). Inorg. Chem., 6: 2233-9 (Dec. 1967).

In the reaction between uranium hexafluoride and hydrazinium (+2) fluoride in liquid hydrogen fluoride at room temperature, with excess uranium hexafluoride, the product was hydrazinium(+2) bishexafluorouranate(V), $N_2H_6(UF_6)_2$, and, with excess hydrazinium (+2) fluoride, the product was hydrazinium(+2) heptafluorouranate (V), $N_2H_5UF_7$. The analogous reaction with hydroxylammonium fluoride produced mixtures of hydroxylammonium and nitrosyl hexafluorouranates(V). X-ray powder patterns, infrared spectra, and magnetic susceptibilities of the solids are given. In the Raman spectra of the hydrogen fluoride solutions of these materials, the 628-cm^{-1} band was assigned to the principal symmetric vibration of UF_6^- ion. The thermal decompositions in argon are discussed in terms of the schemes

$$N_2H_6(UF_6)_2 \xrightarrow{120°} N_2H_5UF_5 + UF_4 \cdot nHF \xrightarrow{250°} NH_4F \cdot 3UF_4 \xrightarrow{300°} 3UF_4 \cdot HF \xrightarrow{380°} UF_4 \text{ and } (NH_3OH)UF_6 + NOUF_6 \xrightarrow{110°} (NH_3OH)UF_5 + NOUF_6 \xrightarrow{170°} \text{unknown} \xrightarrow{350°} UF_4$$

Hydrazinium(+2) fluoride solubility inhydrogen fluoride at 0° was found to be 15 g of $N_2H_6F_2$/100 g of HF. $N_2H_6^{2+}$ is the only important cationic species in such solutions. (auth)

4103 PREPARATION OF URANIUM DISULFIDE FROM URANIUM CHLORIDE. Yoshihara, Kazuhiro; Kanno, Masayoshi; Mukaibo, Takashi (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo), 4: 578-81(Nov. 1967).

A method was developed for the preparation of US_2 using UCl_4, as a first step in the preparation of uranium monosulfide. The reaction of UCl_4, Al, and H_2S proved to be quite practical. It was confirmed by chemical analysis and x-ray diffraction analysis

that almost pure US_2 was obtained at temperatures above 400°C, and the conversion efficiency of uranium reached almost 100%. (auth)

4104 MECHANISM OF THE ACID-CATALYZED HYDRATION OF PHENYLPROPIOLIC ACID. Noyce Sr., Donald S.; Matesich, Mary Andrew; Peterson, Paul E. (Univ. of California, Berkeley). J. Amer. Chem. Soc., 89: 6225-30(1967).

In 62 to 70% sulfuric acid at 25° phenylpropiolic acid is hydrated at a convenient rate to benzoylacetic acid, which decarboxylates more slowly to acetophenone. Rate constants, obtained spectrophotometrically and corrected for decarboxylation, for p-methoxy-, p-methyl-, unsubstituted, p-chloro-, m-chloro-, and 3,4-dichlorophenylpropiolic acids show strict proportionality to h_0, plots of log k vs H_0 having essentially unit slope. Hydration rates are quite sensitive to the presence of electron-donating substituents in the phenyl ring; rates for the first five compounds extrapolated to 50% H_2SO_4 at 25° correlated with σ^+ with a ρ of -4.77 ± 0.07. The first four acids hydrate some four times faster in $H_2O-H_2SO_4$ than in $D_2O-D_2SO_4$ of the same mole fraction sulfate at 25°. Rates determined at 25 and 44° for p-chlorophenylpropiolic acid correspond to an activation energy of 23.7 ± 1.2 kcal/mole and an entropy of activation of -23 ± 4 eu. These results are most consistent with a mechanism involving rate-determining protonation of the α-carbon of phenylpropiolic acid to give a benzyl vinyl cation. A mechanism involving the formation of phenyltrihydroxyallene by 1,4 addition of water, followed by rate-limiting carbon protonation of the allene, is not in agreement with these experimental observations, but is not rigorously excluded by them. (auth)

4105 ELIMINATION MECHANISMS. POSITION OF PROTON AND SUBSTITUENT EFFECTS UPON GEOMETRY IN E2 TRANSITION STATES. Steffa, Louis J.; Thornton, Edward R. (Univ. of Pennsylvania, Philadelphia). J. Amer. Chem. Soc., 89: 6149-56 (Nov. 22, 1967).

The isotope effects for DO^- in D_2O vs HO^- in H_2O as attacking bases in the E2, bimolecular elimination, reactions of β-phenethyl derivatives were determined; at 80.45°, $k_{DO^-}/k_{HO^-} = 1.79 \pm 0.04$, 1.57 ± 0.04, 1.62 ± 0.04, 1.73 ± 0.05 for β-phenethyltrimethylammonium, β-phenethyldimethylsulfonium, β-phenethylphenyldimethylammonium, and β-(p-chlorophenyl)ethyltrimethylammonium ions, respectively. The strong effects observed indicated extensive proton transfer to the base. These and other substituent effects are discussed in terms of hypotheses for predicting substituent effects on transition-state structure. Isotope effects for (2-bromoethyl)benzene in 40% dioxane–H_2O and $-D_2O$, and for β-phenylethyltrimethylammonium ion in 50% H_2O-D_2O, were also determined. (auth)

4106 BOND ENERGIES IN URANYL COMPLEXES. Vdovenko, V. M.; Mashirov, L. G.; Suglobov, D. N. Dokl. Akad. Nauk SSSR, 174: 382-5(May 11, 1967). (In Russian).

The correspondence between binding energy E and the number of electron pairs n taking part in the formation of chemical bonds is used as a criterion in distributing the total energy of formation among individual bonds. The value of n can be determined experimentally from the bond length, force constant, etc., The U–O binding energy in a number of U(IV) and U(VI) compounds were estimated by this method from infrared absorption data on uranyl complexes. The U–O binding energies varied from 197 kcal (n = 2.52) in $UO_2(ClO_4)_2(CH_3NO_2)_2$ to 178 kcal (n = 2.13) in $(NH_4)_4[UO_2(CO_3)_3]$. The U–O ligand bond energies were 20.5 kcal (n = 0.15) for the CH_3NO_2 ligand in $UO_2(ClO_4)_2(CH_3NO_2)_2$, 29 kcal (n = 0.22) for the H_2O ligand in $UO_2(H_2O)_5(ClO_4)_2$, 31 kcal (n = 0.24 for the $(C_4H_9)_2O$ ligand in $UO_2(ClO_4)_2[(C_4H_9)_2O]_2$, 35 kcal (n = 0.28) for the $(C_4H_9O)_3$ PO ligand in $UO_2(ClO_4)_2(TBP)_2$, 22 kcal (n = 0.17) for the ClO_4^- ligand in $R_4N[UO_2(ClO_4)_3]$(R = $C_{21}H_{10}$), 33 kcal (n = 0.26) for the ClO_4^- ligand in $(R_4N)_2[UO_2(ClO_4)_4]$, 26 kcal (n = 0.19) for the NO_3^- ligand in $R_4N[UO_2(NO_3)_3]$, 29 kcal (n = 0.22) for the $C_2O_4^{2-}$ ligand in $(NH_4)_4[UO_2(C_2O_4)_3]$, 30.5 kcal (n = 0.23) for the CH_3COO^- ligand in $R_4N[UO_2PCH_3COO)_3]$, and 36 kcal (n = 0.29) for the CO_3^{2-} ligand in $(NH_4)_4[UO_2(CO_3)_3]$. The metal–ligand binding energies are ordinarily not known, because the lattice energies of the complexes are not known. The U–O binding energies were also estimated from spectroscopic data and were found to be in relatively good agreement with the values obtained from the infrared data. The binding energy E as a function of n was also estimated from the Mie equation for a harmonic oscillator: $E = k\mu r^2/mm$. Here mm is a product characterizing the attraction and repulsion of two particles; k is the force constant; μ is the reduced mass, and r is the interatomic distance. (TTT)

4107 WIDTH OF THE FORBIDDEN ZONE OF RARE-EARTH METAL OXIDES. Derbeneva, S. S.; Batsanov, S. S. (Inst. of Thermal Physics, Novosibirsk, USSR). Dokl. Akad. Nauk SSSR, 175: 1062-3(Aug. 11, 1967). (In Russian).

Characteristics of rare earth oxides were studied by plotting the reflection spectra from polycrystalline specimens. The spectra and a table of the widths of forbidden zones for La_2O_3, CeO_2, Nd_2O_3, Sm_2O_3, Eu_2O_3, Gd_2O_3, Dy_2O_3, Ho_2O_3, Er_2O_3, Tm_2O_3, Yb_2O_3, Lu_2O_3, and Y_2O_3 are included. The data revealed that ΔE of Lu_2O_3 varied within the range from 4.4 to 5.6 eV, with general increases with increasing atomic number. However, direct dependence was not established. (R.V.J.)

4108 INTERACTION OF URANIUM OXIDES WITH OXIDES OF LANTHANUM, SAMARIUM, DYSPROSIUM, AND YTTERBIUM. Koshcheev, G. G.; Kovba, L. M.; Spitsyn, V. I. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 175: 92-4(July 1, 1967). (In Russian).

The interaction of uranium oxides with La, Sm, Dy, and Yb oxides was studied by means of x-ray and coulometric analyses. Phase relationships in $R_2O_3-UO_2-UO_3$ systems studied under different oxidation-reduction and temperature conditions were plotted. In $R_2O_3-UO_2-UO_3$ systems roasted in air at 1200°C, the uranium oxides reacting with La and Sm oxides formed rhombohedral phases $UO_3 \cdot 3R_2O_3(Me_7O_{12})$ and $2UO_3 \cdot 3R_2O_3$ (Me_6O_{15}); with Dy and Yb oxides, only rhombohedral phases of Me_7O_{12} type were obtained. A third rhombohedral phase of the composition $2La_2O_3 \cdot U_2O_9$ was obtained with La oxide at 1100°C; this phase converts to the solid solution $(U,La)O_{2\pm x}$ at higher temperatures. A single-phase solid solution with a fluorite-type structure in the cerium (La,Sm) subgroup is present in preparations containing from 15 mole % R_2O_3, and in the yttrium (Dy,Yb) subgroup from 30.0 mole % R_2O_3 and above. Single-phase preparations of the binary oxides $UO_3 \cdot 3R_2O_3$ were obtained only in the case of stoichiometric compositions. Above and below 75.0 mole % R_2O_3 along the $R_2O_3-UO_3$ line, the rhombohedral phase coexists with the R_2O_3 phase or the fluorite-type solid solution phase. The binary oxide $2UO_3 \cdot 3La_2O_3$ in the pure form was obtained after a second prolonged anneal (200 hr at 1000°C). In vacuum treatment of the systems $UO_2-R_2O_3$ (R being La, Sm, Dy, Yb) at 1600 to 1800°C as well as in reduction with hydrogen at 1100°C of samples obtained by roasting in air at 1200°C, it was found that up to 40.0 mole % R_2O_3 the degree of oxidation of uranium changes with the content of the rare earth oxide. The $R_2O_3-UO_2$ sections could not be studied because the oxidation of uranium could not be avoided. (ATD)

4109 ^{13}C ISOTOPE EFFECTS IN THE DECARBOXYLATION OF QUINALDIC ACID IN WATER MEDIUM. Zielinski, Mieczyslaw (Univ. of Chicago). J. Chem. Phys., 47: 3686-7(Nov. 1, 1967).

The large temperature dependence of the ^{13}C isotope effect on decarboxylation of quinaldic acid in water was caused partially by different vapor pressures of water over the aqueous solution of quinaldic acid. There was a small negative temperature dependence of the ^{13}C isotope effect on quinaldic acid decarboxylated below its melting point. (M.C.G.)

4110 VIBRATIONAL SPECTRA AND FORCE CONSTANTS FOR NITROSYL FLUORIDE AND ^{15}N AND ^{18}O SPECIES. Jones, Llewellyn H.; Asprey, Larned B.; Ryan, Robert R. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 47: 3371-6(Nov. 1, 1967).

From infrared absorption studies in the gaseous phase, the fundamental harmonic vibrational frequencies were determined for $^{16}O^{14}NF$, $^{16}O^{15}NF$, $^{18}O^{14}NF$, and $^{18}O^{15}NF$. Two quite different force constant solutions were obtained in a general quadratic valence force field. With the aid of centrifugal distortion constants and the inertial defect, it was possible to select the true force constant solution: $F_{NO} = 15.9$ mdyn $Å^{-1}$; $F_{NF} = 2.3$ mdyn $Å^{-1}$; $F_{\alpha} = 1.8$ mdyn · $Å rad^{-2}$; $F_{NO,NF} = 2.5$ mdyn $Å^{-1}$; $F_{NO,\alpha} = 0.27$ mdyn rad^{-1}; $F_{NF,\alpha} = 0.20$ mdyn rad^{-1}. These force constants were converted to those of a modified Urey–Bradley force field and a general quadratic central force field. It is shown that the latter gives unreasonable force constants. Interaction displacement coordinates were calculated and correlated qualitatively with valence-bond theory. (auth)

4111 STUDIES IN DECARBOXYLATION. PART V. KINETIC ISOTOPE EFFECTS IN THE GAS-PHASE THERMAL DECARBOXYLATION OF 2,2-DIMETHYL-4-PHENYLBUT-3-ENOIC ACID. Bigley, D. B.; Thurman, J. C. (Univ. of Kent, Canterbury, Eng.). J. Chem. Soc., B, No. 10, 941-3(1967).

2,2-Dimethyl-4-phenylbut-3-enoic [^3H] acid showed a kinetic isotope effect of 2.87 ± 0.23 at 559.2°K and 2.81 ± 0.18 at 543.0°K There was no deuterium exchange before decarboxylation. For the [^{14}C] acid the effect was 1.035 ± 0.010 at 551.0°K. These observations, together with the effect of substituents on the rate of decarboxylation described in Part IV (J. Chem. Soc. (B), 557(1967)), require that all the bonds in the transition state are either making or breaking simultaneously. (auth) (UK)

4112 MODEL CALCULATIONS OF PRIMARY HYDROGEN ISOTOPE EFFECTS. O'Ferrall, R. A. More; Kouba, J.

(Illinois Inst. of Tech., Chicago). J. Chem. Soc., B, No. 10, 985-90(1967).

Model calculations of primary hydrogen isotope effects for four and five-centre transition states, taking account of bending vibrations and proton tunnelling, are reported. The results reinforce those based on consideration of stretching vibrations alone, and suggest that both zero-point energy and tunnelling contributions are at a maximum for a symmetrical transition state. For proton transfer to halide ions, large isotope effects persist for product-like transition states owing to the low frequency of hydrogen bending vibrations. Swain's relation between deuterium and tritium isotope effects is well obeyed. It seems better to consider the reaction co-ordinate mode for an atom transfer reaction as deriving from a translation rather than from a vibration in the reactants. (auth) (UK)

4113 THE CRYSTAL STRUCTURE OF $CsUF_6$. Rosenzweig, Abraham; Cromer, Don T. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Acta Crystallogr., 23: 865-7(1967). (LA-DC-8880).

$CsUF_6$ is rhombohedral, a = 5.417 Å, $\alpha = 95° 29.5'$, space group $R\bar{3}$, with one formula unit per unit cell. The U atom has 6F neighbors at 2.057 Å, which make an octahedron slightly compressed along the threefold axis. The Cs atom has 12 neighbors, 6 at 3.101 and 6 at 3.147 Å. The compound is isostructural with $KOsF_6$. (auth) (Denmark)

4114 TECHNIQUES FOR THE MEASUREMENT OF ENTROPY AND THEIR APPLICATION TO SOME URANIUM COMPOUNDS. Martin, J. F. (National Physical Lab., Teddington, Eng.). Proc. Brit. Ceramic Soc., No. 8, 1-13(June 1967).

From 8th Proceedings of the British Society on Thermodynamics on Ceramic Systems, London, Apr. 19–21, 1966. See CONF-660459.

Equipment for measurement of heat capacities and heats of transition in the temperature range from 10 to 450°K is described. A special feature of the apparatus is the use of automatic devices for recording the experimental data on punched tape, which is then processed by computer. Results of measurements on uranium carbides (UC, $UC_{1.91}$, and U_2C_3) and uranium nitrides ($UN_{1.01}$, $UN_{1.59}$, $UN_{1.73}$) are summarized. (auth)

4115 HALOGEN COMBUSTION CALORIMETRY OF REFRACTORY COMPOUNDS. THE HEATS OF FORMATION OF BORON NITRIDE AND BORON FLUORIDE. Gross, P.; Hayman, C.; Stuart, M. C. (Fulmer Research Inst. Ltd., Stoke Poges, Eng.). Proc. Brit. Ceramic Soc., No. 8, 39-50(June 1967).

From 8th Proceedings of the British Society on Thermodynamics on Ceramic Systems, London, Apr. 19–21, 1966. See CONF-660459.

A survey was made of calorimetric halogenation techniques and apparatus applicable to the determination of the heats of formation of refractory compounds. A description is given of the determination of the heat of formation of hexagonal boron nitride by combustion in fluorine and of that of boron trifluoride on which the former is based. The values obtained, taking the β-rhombohedral form as standard state for boron, are: ΔH^0_{298}, BF_3(gas) = −271.2 ± 0.5 kcal; ΔH^0_{1294}, BN(hexagonal) = −60.2 ± 0.5 kcal. (auth)

4116 GALVANIC CELLS AND GAS EQUILIBRATION TECHNIQUES. Markin, T. L.; Bones, R. J.; Wheeler, V. J. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceramic Soc., No. 8, 51-66(June 1967).

From 8th Proceedings of the British Society on Thermodynamics on Ceramic Systems, London, Apr. 19–21, 1966. See CONF-660459.

A high-temperature galvanic cell containing solid electrolytes, reversible to oxygen ions only, was used to measure oxygen potentials of nonstoichiometric oxides of uranium and plutonium and metal/metal oxides, employing Ni, NiO and Fe, FeO as the reference electrodes. The cell functions satisfactorily at very low oxygen potentials by comparison with data for the CeO_{2-x} system obtained by CO/CO_2 equilibration experiments. A technique of titration of oxygen ions from the standard metal/metal oxide to uranium oxide was used for the region close to stoichiometry where large changes in oxygen potential occur for a small change in composition. When sufficient attention is paid to practical aspects, which are discussed, these cells can function satisfactorily over a wide range of temperature and oxygen potential. A galvanic cell containing electrolytes reversible to fluoride ions was developed and a high degree of internal consistency demonstrated by measurements of three sets of related cells. A technique of gas-equilibration in a sealed silica system was developed, by which an oxide at temperatures above 1900°C is equilibrated with a reference metal/metal oxide mixture, which is held at a lower temperature; oxygen is transferred by means of a H_2/H_2O gas mixture. (auth)

4117 MASS SPECTROMETRIC STUDIES OF THE VAPORIZATION OF REFRACTORY COMPOUNDS. Drowart, J.; Pattoret, A.; Smoes, S. (Univ. Libre, Brussels). Proc. Brit. Ceramic Soc., No. 8, 67-89(June 1967).

From 8th Proceedings of the British Society on Thermodynamics on Ceramic Systems, London, Apr. 19–21, 1966. See CONF-660459.

A modified Knudsen cell assembly for use in mass spectrometric studies of the thermodynamics of vaporization of refractory substances is described. The assembly can be positioned from outside the instrument, permitting direct comparison of pressures in different systems located in adjacent twin cells or of free-surface vaporization and effusion under equilibrium conditions. The assembly further makes possible determinations of absolute pressure by condensation of a known fraction of the effusing vapor. Thermochemical applications of the mass spectrometer–Knudsen cell technique for study of refractory compounds are reviewed. Dissociation energies of the gaseous oxides BO, ScO, YO, LaO, VO, CeO, UO, UO_2, and UO_3 and of the gaseous sulfides GeS, ScS, VS, CrS, FeS, MnS, CoS, NiS, CuS, YS, LaS, and CeS derived from exchange reactions are presented and where possible compared with literature data. Partial pressures for U, UO, and UO_2 are given for the U–UO_2 two-phase system between 1700 and 2350°K and at 2250°K throughout the $UO_{1.85}$–$UO_{2.0}$ homogeneity range. The congruently vaporizing composition was determined to be $UO_{1.987(+0.006-0.010)}$. (auth)

4118 HEAT CAPACITY OF SOME URANATES. Jakes, D.; Schauer, V. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Proc. Brit. Ceramic Soc., No. 8, 123-5(June 1967).

From 8th Proceedings of the British Society on Thermodynamics on Ceramic Systems, London, Apr. 19–21, 1966. See CONF-660459.

The heat contents of $MnUO_4$, $NiUO_4$, and $MgUO_4$ were measured with an isothermal drop calorimeter in the temperature range from 500 to 1000°K. Equations for calculating the heat capacities in the considered interval of temperature are given. (auth)

4119 THERMODYNAMIC DATA OF UN_x (x_x = 1.5 TO 1.75). Naoumidis, A.; Stoecker, H. J. (Kernforschungsanlage, Juelich, Ger.). Proc. Brit. Ceramic Soc., No. 8, 193-200(June 1967).

From 8th Proceedings of the British Society on Thermodynamics on Ceramic Systems, London, Apr. 19–21, 1966. See CONF-660459.

The nitriding of cubic U_2N_3 (Mn_2O_3 structure) leads to products that can be considered as solid solutions of cubic U_2N_3 and the hypothetical UN_2 (fluorite structure). Maximum nitrogen content at atmospheric pressure corresponds to $UN_{1.75}$, and at high pressures to $UN_{1.81}$. Equilibrium pressures were measured at different temperatures, and thermodynamic data for compositions between $UN_{1.5}$ and $UN_{1.75}$ are presented. (auth)

4120 KINETICS OF THE HOMOGENEOUS EXCHANGE REACTION: $^{14}-{}^{14}N_2 + {}^{15}-{}^{15}N_2 \rightleftharpoons 2\,{}^{14}-{}^{15}N_2$. SINGLE-PULSE SHOCK-TUBE STUDIES. Bar-Nun, Akiva; Lifshitz, Assa (Hebrew Univ., Jerusalem). J. Chem. Phys., 47: 2878-88(Oct. 15, 1967).

The kinetics of the homogeneous exchange reaction in molecular nitrogen highly diluted in argon was studied in a single-pulse shock tube over a wide range of temperatures, initial pressures, and compositions. The reaction order with respect to the total nitrogen, argon, and the over-all reaction order were determined. A rate law: Rate = $k_b[Ar][N_2^{14}] + k_b[Ar][N_2^{15}]$, which is a sum of two parallel reactions, was found to be compatible with the experimental results $k_b = 10^{13.82\pm0.81} \exp[-(116 \pm 5) \times 10^3/RT]$ cc $mole^{-1} \cdot sec^{-1}$. It was shown that the exchange reaction does not proceed via a radical chain. A mechanism based on vibrational excitation of the nitrogen molecule to a critical vibrational level as a rate determining step is proposed. A rate constant, computed from available vibrational relaxation data in nitrogen agrees very well with the observed rate constant. It was found that slight amounts of oxygen, up to $O_2/N_2 \sim 0.01$, had very little effect on the reaction rate. In the presence of higher oxygen concentration, $O_2/N_2 \sim 0.5$, the exchange proceeds mainly via an atom displacement mechanism. An approximate rate constant for the reaction $N^* + N_2 \xrightarrow{k_3} N + N_2^*$, $k_3 = 3 \times 10^{11}$ cc $mole^{-1} \cdot sec^{-1}$ at 3400°K was obtained. The temperature range involved in this study, i.e., 3200 to 3800°K, is the highest ever reported in a single-pulse shock-tube study. The gas-dynamic conditions and an innovation in the design of the shock tube are briefly described and discussed. (auth)

4121 HOMOGENEOUS METAL-CATALYZED ISOTOPIC HYDROGEN EXCHANGE IN AROMATIC COMPOUNDS. THE LABELING OF NITROBENZENE, BROMOBENZENE, NAPHTHALENE, AND ACETOPHENONE. Garnett, J. L.; Hodges, R. J. (New South Wales Univ., Kensington). Chem. Commun., 19: 1001-3 (1967).

Homogeneous Pt^{II} salt catalysis exchange between aromatic compounds and isotopic water was previously reported, and it was discovered that rapid exchange occurs in this way with the above important representative compounds, and that certain groups of compounds that are difficult to label by the heterogeneous method can be satisfactorily tagged by this homogeneous procedure. Experimental details are described for bromobenzene, employing sodium chloroplatinite together with HCl dissolved in acetic acid. The acetic acid is necessary in order to produce a homogeneous phase, and a little mineral acid to prevent precipitation of platinum metal. The method is applicable to either deuterium or tritium. The observation that nitrobenzene exchanges homogeneously is interesting, since nitro-groups poison exchange by heterogeneous methods. A whole range of nitro-aromatic compounds is amenable to isotopic hydrogen labeling in one step by the the new technique. Results with nitrobenzene indicate that free hydrogen atoms or metal hydride complexes do not participate in the mechanism of the homogeneous process. Mass spectrometric and NMR studies indicate that the exchange is not acid catalyzed, but occurs via a homogeneous Pt^{II} complex. The ability to label bromobenzene readily is useful since this compound is a valuable intermediate for Grignard and related reactions for the synthesis of other labeled products; deuteration is particularly rapid in the meta- and para-positions. With naphthalene, exchange is particularly rapid in the β-positions. The results for acetophenone are interesting since this compound does not exchange heterogeneously in the ring. Homogeneous exchange is more extensive in the meta- and para-positions. (UK)

4122 THE KINETICS AND MECHANISMS OF AROMATIC HALOGEN SUBSTITUTION. XXVI. CONFIRMATION OF THE EXISTENCE OF A SOLVENT DEUTERIUM ISOTOPE EFFECT IN THE BROMINATION OF PHENOL IN ACETIC ACID. de la Mare, P. B. D.; El Dusouqui, O. M. H. (London Univ.). J. Chem. Soc. B, No. 3, 251-2(1967).

The bromination of phenol in acetic acid containing lithium perchlorate and lithium bromide was found to be faster by a factor of 1.8 to 1.9 than that of o-deuteriophenol in deuterioacetic acid containing the same salts. (auth) (UK)

4123 ISOTOPE EFFECTS IN THE CONDUCTIVITY OF KH_2PO_4 AND KD_2PO_4. O'Keefe, M.; Perrino, C. T. (Arizona State Univ., Tempe). J. Phys. Chem. Solids, 28: 1086-8(June 1967).

Electric conductivity temperature-dependence measurements of pure and sulphate-doped KD_2PO_4 are presented and compared with those detained on KH_2PO_4. The combined results were interpreted using the theory of ferroelectric transition proposed by Imry, et al. (J. chem. Phys. 43: 2332 (1965)). A significant feature of this interpretation is that the loosening of the hydrogen bond network is unlikely to result in melting, on hypothesis which is strengthened by the observation that there is no large isotope effect in melting. (UK)

4124 RADIOISOTOPIC EXCHANGE BETWEEN CHLORINE GAS AND MOLTEN $PbCl_2$–KCl. Kowalski, M.; Harrington, G. W. (Temple Univ., Philadelphia). Inorg. Nucl. Chem. Lett., 3: 121-4(Apr. 1967).

Explanation of the results of studies on the solubility of Cl_2 in molten mixtures of $PbCl_2$ and KCl will probably involve the ion-induced dipole species Cl_3^-, and it was decided to confirm the existence of such a species by radioactive exchange. Chlorine was bubbled through a melt comprising $PbCl_2$/KCl, containing a small amount of $K^{36}Cl$, at 500°C. The Cl_2 was then flushed from the melt with N_2, all the gas passing through the melt being collected in aqueous KI. Samples of the melt were also examined prior to saturating and after flushing. The KCl generated in the KI flasks and the melt samples were both counted. Results are tabulated. The activity of the melt after passage of Cl_2 showed an 8% fall in ^{36}Cl activity, and the Cl_2 collected as KCl during passage of the gas was about 12 times as active as that collected during the N_2 flush of dissolved Cl_2. The drop in melt activity indicated that some type of polychloride complex formed in the melt, and the activity of the collected Cl_2 indicated that this species exchanged with the melt and the dissolved gas. The possibility of the complex species being formed from the first available Cl_2 gas, and remaining tightly bound, was disproved. Work is planned to determine the amount and rate of exchange as functions of melt composition and temperature. (UK)

4125 ENTHALPIES OF INTRAMOLECULAR HYDROGEN BONDS OF ORTHOHALOPHENOLS AND DEUTERATED ORTHOHALOPHENOLS IN THE VAPOR PHASE. Lin, Tien-sung; Fishman, E. (Syracuse Univ., N. Y.). Spectrochim. Acta, Part A, 23: 491-500(Mar. 1967).

Infrared absorption in the O–H and O–D stretching regions were recorded for orthohalophenols and deuterated orthohalophenols in the vapor phase at temperatures ranging from their boiling points to 290°C. ΔH's for intramolecular bridge bond formation were calculated from the change in relative peak heights with temperature. The fluoro compounds did not yield clearly defined cis and trans peaks. For the chloro, bromo, and iodo compounds, the ΔH's were 3.41, 3.13, and 2.75 kcal/mole for the hydrogen bonds and 2.81, 2.65 and 2.65 kcal/mole for the deutero bridge bonds. The average standard deviation of these values was about 7 per cent. An explanation of the effect of deuteration on the apparent bond strength is offered based on partial excitation of the out-of-plane O–H and O–D bending modes of the cis isomers. (auth) (UK)

4126 INFRARED SPECTRA OF SOME DEUTERATED TERTIARY AMIDES. Dorris, K. L.; Siddall III, T. H.; Stewart, W. E.; Good, Mary L. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Spectrochim. Acta, Part A, 23: 1657-60(June 1967). (DP-MS-66-60).

Infrared frequency measurements of the C=O and amide C–N stretching modes of N,N-dimethylacetamide-d_9 and some of its derivatives were made in the liquid and vapor state. The observed changes of frequencies of these bands with change of state and chlorine substitution confirmed the assignments. (auth) (UK)

4127 KINETICS OF THE OXIDATION OF THE FORMATE AND DEUTERIOFORMATE IONS BY PERMANGANATE. Bell, R. P.; Onwood, D. P. (Oxford Univ.). J. Chem. Soc., B, No. 2, 150-2(1967).

The reaction between permanganate ions and formate or deuteriоformate ions was investigated kinetically between 0 and 50°, both in very dilute solutions and in M-sodium perchlorate. In the former the kinetic salt effect agreed with the predictions of the Debye–Hückel theory, and velocity constants at infinite dilution were obtained by extrapolation. Both at infinite dilution and in M-perchlorate the difference in activation energies for the two isotopic species was approximately 1.2 kcal/mole, and the ratio A_H/A_D did not differ significantly from unity. There was a small solvent isotope effect. (auth) (UK)

4128 THE VISCOSITY OF HEAVY WATER AT HIGH PRESSURES IN THE TEMPERATURE RANGE FROM 4 TO 100°C. Agaev, N. A.; Yusibova, A. D. At. Energ. (USSR), 23: 149-51(1967). (In Russian).

The viscosity of heavy water was determined by means of 2 capillary viscometers at 1 to 1200 kg/cm^2; using one instrument at 4 to 75°C and the other at 50 to 100°C. During the measurements, the temperature was kept constant within ±0.005°C. It was measured by means of a reference platinum resistance thermometer, while the experimental pressure was created by means of 2 piston-type manometers. The Reynolds number of 400 was not exceeded during the flow of the water. Graphic treatment of the water indicated that the values obtained were within 0.2% of the most probable ones. It was found that near the freezing point, the viscosity isotherms of heavy water exhibit the same anomalies as those of ordinary water and as the pressure increases the viscosity decreases passing through a minimum and increasing again. This anomaly disappears at 35 to 40°C and the viscosity of heavy water increases with the pressure. Comparison of the data with earlier results near the saturation point revealed an agreement within ±2%, which is within the limits of experimental error. (TTT)

4129 ADSORPTION MECHANISM OF RADIOISOTOPES ON METAL AND OXIDE SURFACES. Herczynska, E. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 125-9 (1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Phenomena occurring at the interface between metals and aqueous electrolytes are of technical importance in mineral flotation, aqueous corrosion, etc. Studies were made of the adsorption of radioisotopes from aqueous solutions on the surface of metals as a function of pH, concentration of the solutions, nature of the ions, and nature of the metal surfaces. The adsorption of ^{131}I, $^{35}SO_4^{2-}$, $^{32}PO_4^{3-}$, $^{60}Co^{2+}$, $^{45}Ca^{2+}$, $^{65}Zn^{2+}$, and $^{137}Cs^+$ was studied on Au, Pt, stainless steel, Sn, Cu, Al, Zn, Pb, glass, and perspex surfaces. In addition, the adsorption of H^+ and H^- ions was studied on Al, Ni, Fe, and their oxides. An attempt was made to derive a formula for the adsorption isotherm of the ions and, in some cases, to check it quantitatively. (auth)

4130 CHEMICAL PROBLEMS OF SALT FUEL. Taube, Mieczyslaw (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 187-91(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

The possibility of breeding in fast reactors and the advantage of

continuous fuel regeneration were used as a criterion for selection of liquid-salt fuel. The selected fuel consists of $^{239}PuCl_3$ and $^{238}UCl_3$ dissolved in $KCl-CaCl_2-MgCl_2$. The properties of these salts during irradiation (balance of Cl_2 and isotopic and chemical changes) suggest the stability of such a fuel. From high-temperature-extraction vapor-pressure measurements, electron absorption spectra electromigration, and others, some information was obtained about the structure of Cl^- complexes of U, Pu, Am, and Cm. (auth)

4131 STUDIES ON CERAMIC FUELS. Dembinski, Wojciech; Deptula, Andrzej; Rykowski, Stanislaw (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 193-204 (1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Studies on some uranium compounds, used for production of UO_2 of good sinterability, were carried out. The mechanism of precipitation and the composition of ammonium polyuranates precipitated from the aqueous $UO_2(NO_3)_2$ solution were investigated. The course of precipitation from $UO_2(NO_3)_2$ solutions containing urea were also investigated. It was found that the composition of the precipitate depends on the way in which the reaction is carried out and the urea concentration; i.e., urea uranate with the composition: $H_2O \cdot UO_3 \cdot 2CO(NH_2)_2$ or ammonium-urea polyuranates are formed. The conditions for production of urea uranate by homogeneous precipitation were found. Some parameters of production of sintered pellets from UO_2, obtained by decomposition and reduction of ammonium polyuranates were studied. Pellets of various shapes and with densities from 10.0 to 10.3 g/cm^3 were obtained. (auth)

4132 STRUCTURE OF URANIUM COMPOUNDS. Jezowska-Trzebiatowska, B.; Bartecki, A.; Bukietynska, K.; Drozdzynski, J.; Ernst, S.; Kakolowicz, W.; Kedzia, B.; Legendziewicz, J.; Wieczorek, H. (Univ., Wroclaw. Technical Univ., Wroclaw). Nukleonika, 10: Suppl., 207-20(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Electronic spectra of uranyl salts were investigated in several organic solvents. The linear structure of uranyl ion was defined on this basis. Examination of simple salts of this group in the infrared region gave further confirmation of its linearity. The influence of solvents on the vibrational structure of these spectra is discussed. D_{2h} structure of anhydrous $UO_2(NO_3)_2$ and its hydrates is proposed. The influence of chelation on the uranyl diketones electronic spectra, magnetic properties, dipole moments, and stability is discussed. Conductometric data, obtained for hydrated and anhydrous $UO_2(NO_3)_2$ solutions in organic solvents are discussed. Spectroscopic examination of U(IV) in solution, as well as investigation of the magnetic susceptibility of certain U(IV) compounds in the solid phase, confirmed the $5f^2$ configuration of this ion. It was demonstrated that the influence of the ligand field on 5f levels is stronger than on 4f levels. As a measure of this influence a magnitude ξ_{3p} was accepted. Based on the change of this magnitude, a spectrochemical series for U(IV) is proposed It was found that ξ_{3p} may also be applied to investigations of the complexing equilibria in U(IV) salts solution. From the confirmed dependence of crystal field symmetry on magnetic properties, a division of U(IV) compounds was proposed, permitting magnetic properties to be predicted for compounds of known symmetry. The stable U(III) solutions obtained enabled spectroscopic investigations, which demonstrated, most probably, $5f^26d^1$ electronic structure of this ion. (auth)

4133 DIELECTRIC INVESTIGATIONS OF TRIBUTYL-PHOSPHATE AND SOME OF ITS SYSTEMS. Hurwic, J.; Michalczyk, J. (Technical Univ., Warsaw). Nukleonika, 10: Suppl., 221-7(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Tributylphosphate (TBP) alone and in mixtures with other organic compounds is used in extraction of U salts and some other heavy metals. The dielectric behavior of reagents have a decisive influence on the process. Results of dielectric investigations of TBP, some of its solutions, and complexes with uranyl, thorium, and lanthanum nitrates are presented. On the basis of measurements of dielectric constant, refractive index, and density of dilute solutions of TBP in CCl_4 the dipole moment of TBP: μ = 3.01 D was calculated by the extrapolation method. Analogous investigations of benzene solutions led to the value: μ = 3.05 D. Measurements of pure liquid by the Onsager-Böttcher method gave μ = 3.28 D. Using Syrkin's formula a still higher value: μ = 3.37 D was obtained. The Kirkwoods coefficient was experimentally determined (g = 2.0); it was deduced on this basis that dimolecular aggregates with coupling with the same dipole orientation are present in pure TBP. Liquid TBP solutions in nonpolar solvents: benzene, CCl_4, and nearly nonpolar dioxane were investigated. The more dilute the TBP solution was the smaller the deviation of molar orientation polarization of TBP from its value in the gaseous phase. This is probably a result of the decomposition of chain aggregates and can be accompanied by formation of antiparallel coupling. Weak interactions between the TBP and solvent molecules of the type: permanent dipole — induced dipole are also possible. The deviations of dielectric properties of the ethanol – TBP system from additivity may suggest a possible formation of intermolecular hydrogen bridges. From investigations of the tricomponents mixture: uranyl nitrate – TBP – benzene and by assumption of the formation of a $UO_2(NO_3)_2 \cdot 2TBP$ complex, its dipole moment μ = 2.70 D was determined. Taking into account that in the most concentrated solution of $UO_2(NO_3)_2$ in TBP the relative content of TBP was smaller than 2:1, a supposition that greater complexes: $2UO_2(NO_3)_2 \cdot 3TBP$ or $3UO_2(NO_3)_2 \cdot 4TBP$ are formed as well, was put forward. This was further confirmed by measurement of benzene freezing temperature decrease after dissolving in it the $UO_2(NO_3)_2$ in TBP solution. In experiments involving the $Th(NO_3)_4 - TBP - CCl_4$ system, the dipole moment of the $Th(NO_3)_4 \cdot 2TBP$ complex, μ = 5.8 D, was determined. Similar measurements with lanthanum nitrate led to the value μ = 7.3 D for the dipole moment of the $La(NO_3)_3 \cdot 3TBP$ complex. (auth)

4134 INVESTIGATIONS ON THE TECHNOLOGY OF URANIUM COMPOUNDS, METALLIC URANIUM, METALLIC THORIUM, GRAPHITE FOR NUCLEAR REACTORS, AND OTHER REACTOR MATERIALS. Adamski, T.; Borysowski, J.; Czarnecka, W.; (and others) (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 279-87(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Some results of investigations carried on U metal and U compounds technology are reported. Investigations concerning the oxide fuel materials, graphite, and some other reactor materials are discussed. A detailed description of technological processes for conversion of uranyl nitrate into metallic U are described. (auth)

4135 TRENDS OF RADIOCHEMICAL RESEARCH AT DEPARTMENT OF PHYSICAL CHEMISTRY, TECHNICAL UNIVERSITY OF LODZ. Bem, H.; Dorabialska, A.; Reimschussel, W.; Sugier, H.; Swiatkowski, W. (Technical Univ., Lodz, Poland). Nukleonika, 10: Suppl., 339-46(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Current research deals with the following: the kinetics of metals iodination with the use of ^{131}I vapor or solution; the kinetics of sorption and ^{14}C tracer exchange on carbonates; the kinetics of allotropic changes of S, Se, and Te under the influence of ionizing radiation; the kinetics of isotopic exchange in the system liquid-gas on a permanent renewing surface; and the use of radioisotopes to determining the molecular weight of graft copolymers. (auth)

4136 ISOTOPE EXCHANGE METHOD USING ^{14}C IN STUDIES OF SACCHARIDE MATERIALS. Swiderski, J.; Blicharski, P.; Ostalska, K.; Pawlak, Z.; Strucinski, J.; Temeriusz, A.; Siarkiewicz, E.; Skup, A.; Piorkowska, M. (Univ. of Warsaw). Nukleonika, 10: Suppl., 347-52(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

The reactivity of substituents at the different C atoms of the pyranose ring was studied. The experiments were conducted using the derivatives of monosaccharides and disaccharides. From the results obtained conclusions can be drawn concerning the mechanism of nucleophilic substitution in the carbohydrates. (auth)

4137 INVESTIGATIONS ON APPLICATION OF RADIOISOTOPES CARRIED ON IN THE INSTITUTE OF GENERAL CHEMISTRY AND OTHER RESEARCH INSTITUTES OF MINISTRY OF CHEMICAL INDUSTRY. Grzelewski, L. (Inst. of General Chemistry, Warsaw). Nukleonika, 10: Suppl., 353-9 (1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Investigations carried on connected with problems of organic coatings and corrosion, chemical processes, and catalysis are discussed. (M.C.G.)

4138 RADIOISOTOPIC EXCHANGE IN THE STUDIES ON THE STRUCTURE OF CO-ORDINATION COMPOUNDS. Jezowska-Trzebiatowska, B.; Wajda, S.; Ziolkowski, J.; Pruchnik, F.

(Univ. of Wroclaw). Nukleonika, 10: Suppl., 361-72(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

The method of isotopic exchange was applied as a criterion of the structure and character of metal-ligand bonding in complex compounds. On the basis of kinetic studies on the exchange reaction in homogeneous systems of complex compound and tracer ligands, the structure and character of bonding for the following types of transition metal complex compounds explained: pentacyanonitrosyl complexes of the $[Me(CN)_5NO]^{-3}$ type, where Me = Cr, Mn, Fe, and Co; binuclear complexes of Re(IV); and thiocyanate complexes of the $[Me(CNS)_6]^{-3}$ type, where Me = Cr, V, and Mo. (auth)

4139 INFRARED SPECTROMETRIC INVESTIGATION OF THE DEHYDRATION PRODUCTS OF UF_4 AND PuF_4 CRYSTAL HYDRATES IN A CURRENT OF DEHYDRATED HF. Khanaev, E. I.; Teterin, E. G.; Luk'yanova, L. A. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 6: 789-96(June 1967). (In Russian).

The dehydration products of the tetrafluorides of U and Pu of rhombic syngony and $UF_4 \cdot 4/3H_2O$ of monoclinic syngony were investigated by infrared spectrometry, x radiography, and refractometry. Dehydration of the rhombic crystal hydrates of UF_4 and PuF_4 was accompanied by the formation of a previously undescribed form. The crystal hydrate $UF_4 \cdot 4/3H_2O$ of monoclinic syngony was dehydrated without change of the crystal structure. As the final dehydration product of all the crystal hydrates in the HF current, the corresponding dehydrated tetrafluorides of monoclinic syngony appeared. (auth)

4140 ISOTOPE EXCHANGE OF OXYGEN HETEROATOMS IN PYRYLIUM SALTS. Gard, E. (Inst. of Atomic Physics, Bucharest); Runge, A.; Barabas, A.; Balaban, A. T. J. Label. Compounds, 3: 151-4(Apr.-June 1967). (In German).

Isotopic exchange between 2,4,6-trimethylpyrylium perchlorate and $H_2{}^{18}O$ was investigated. The results show that the oxygen heteroatom of the pyrylium salts exchanges easily with the water oxygen at 100°C. The exchange velocity increased at higher pH values. (J.S.R.)

4141 REACTION OF URANIUM TETRACHLORIDE WITH ALKALI AMIDES. Tschirne, G.; Naumann, D. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Z. Anorg. Allg. Chem., 354: No. 1-2, 50-5(Sept. 1967). (In German).

Uranium imidosalts of the compositions $K_4[U(NH)_3]$ were prepared by interaction between UCl_4 and excess KNH_2 in liquid NH_3; $NaNH_2$ gives amorphous uranium diimide. Molten alkali metal amides react with UCl_4 yielding U nitrides of varying compositions. (auth)

4142 GRAPHICAL PRESENTATION OF RELATIVE VALUES OF THE VAPOR PRESSURE AND THE ENTHALPY OF VAPORIZATION OF THE ELEMENTS. Olette, M. M.; Ancey-Moret, M. F. (Institut de Recherches de la Siderurgie, Saint-Germain-en-Laye, France). Vide, 22: 213-25(July-Aug. 1967). (In French).

Using recent experimental determinations now available of the vapor pressure of elements, a diagram was established showing the variations with temperature of the vapor pressure of the 53 technically most important elements. This diagram can be used, for example, to compare the vapor pressures of different elements at a given temperature. Another diagram was drawn in order to illustrate the evolution of the heats of vaporization of elements with atomic number and to try to establish a relation between the former and the electronic structure. The values selected to draw these diagrams are discussed and these, together with other data of interest, were tabulated. (auth)

4143 INVESTIGATION OF THE ISOTOPIC EXCHANGE OF DEUTERIUM WITH HYDROGEN IN BENZENE UNDER CONDITIONS OF ITS HYDROGENATION ON NICKEL. Zlotina, N. E.; Gudkov, B. S. (Inst. of Organic Chemistry, Kazan). Izv. Akad. Nauk SSSR, Ser. Khim., No. 9, 1940-7(Sept. 1967). (In Russian).

The curves of the temperature dependence of the degree of exchange and hydrogenation of benzene during simultaneous occurrence of this reaction on nickel catalysts have different characters. The introduction of significant quantities of cyclohexane in the original mixture did not affect the degree of hydrogenation of benzene, but it noticeably reduced the degree of exchange at temperatures above 150°C. The curves of the isotopic distribution of cyclohexane, formed in the hydrogenation process (deuteration) of benzene, differed from the curves of the isotopic distribution of exchange products both in benzene and in the separately introduced cyclohexane. The experimental data can be explained by the assumption that the deuterium–hydrogen exchange reaction and the benzene hydrogenation proceeds through intermediate surface compounds. (tr-auth)

4144 DEUTERIUM EXCHANGE BETWEEN n-HYDROCARBONS ON A Pt–ALUMINA CONTACT. Gelbin, David; Wilde, Ernst (Institut fuer Physikalische Chemie, Berlin). Chem. Tech. (Leipzig), 19: 480-3(Aug. 1967). (In German).

The exchange between deuterium and the hydrogen of n-butylene or n-butane occurred rapidly on a Pt–alumina contact at 60°C. At this temperature, however, no exchange was found between deuterated and nondeuterated hydrocarbons. At 300°C on the same contact a significant exchange occurred between deuterated butane and n-butane or n-pentane. The exchange velocity increased with increased hydrocarbon pressure and decreased when the deuterium residue was found on the contact. Pt-free γ-alumina under the same conditions could not activate the exchange between hydrocarbons. The model of the dissociated adsorption was confirmed in these studies. (tr-auth)

4145 PROGRESS IN REACTION KINETICS. VOLUME 3. Porter, G.; Jennings, K. R.; Stevens, B. (eds.). New York, Pergamon Press, 1965. 520p.

Three individual abstracts were prepared. Other topics covered include: theories of the kinetics of biomolecular reactions; reactions of hydrogen atoms in the gas phase; the inhibition of gaseous free radical chain reactions; vibrational relaxation in gases; electronic spectra and kinetics of aromatic free radicals; the kinetics of polymerization of vinyl monomers by lithium alkyls; and the study of radical polymerization in solution. (D.H.M.)

For abstracts of individual papers see: 4173–4175.

4146 KINETICS OF FAST REACTIONS IN THE GAS PHASE; SHOCK TUBE STUDIES OF THE HYDROGEN–OXYGEN, DEUTERIUM–OXYGEN, AND HYDROGEN–NITROUS OXIDE SYSTEMS. Barton, Sydney Charles. Toronto, Univ. of Toronto, 1966. Thesis.

An apparatus in which chemically reacting gas (generally less than 4% reactant in inert diluent) is sampled from a reflected shock wave directly into the ion source of a time-of-flight mass spectrometer was constructed. This apparatus was used to study the following systems: (1) The hydrogen–oxygen reaction. Induction periods were measured over the temperature range from 1400 to 2700°K, using H_2-O_2-Kr and $D_2-O_2-Kr-He$ mixtures of varying composition. The results of the H_2-O_2-Kr studies can be explained in terms of a simple mechanism that involves initiation by a bimolecular reaction between H_2 and O_2 plus the usual three branching steps. A reiterative numerical integration was used to evaluate the rate coefficients of the elementary reactions involved. The $D_2-O_2-Kr-He$ experiments showed conclusively that, while the slow vibrational relaxation of O_2 has an effect on the induction period, concentration effects are much more important, in agreement with previous studies. (2) The thermal decomposition of nitrous oxide. This reaction was investigated over a temperature range from 1780 to 2950°K with total concentrations of $(1.6 \pm .2) \times 10^{-3}$ mol./l., Kr being used as a diluent. The reaction was found to be of the second order and the overall rate given by $d(N_2O)/dt = -4.2 \times 10^9 \exp(-36{,}000/RT)[M][N_2O]$, in l. mol.$^{-1}$ sec.$^{-1}$. The products of decomposition were N_2, O_2, and NO, and the relative amounts indicate that the O atoms produced in the unimolecular decomposition of N_2O quickly react with another N_2O molecule to produce $N_2 + O_2$ or 2NO. The observed activation energy is considerably lower than the values (58 to 65 kcal./mol) reported in other work at much higher pressures. It was suggested previously that the decomposition of N_2O involved excited triplet states of N_2O. The apparent strong dependence of the activation energy on pressure can be accounted for by postulating different rate-controlling steps in different pressure regions. (3) The hydrogen–nitrous oxide reaction. Krypton-diluted reaction mixtures having H_2/N_2O ratios of 0.21, 0.98, and 3.93 were studied under pressure and temperature conditions similar to those of the N_2O study. The products of reaction were H_2O, N_2, O_2, and NO. With increasing H_2/N_2O, H_2O and N_2 become the principal products of reaction. O_2 and NO continuing to be formed in smaller amounts. A mechanism is proposed and discussed. (Disser. Abstr.)

4147 HEAT OF SOLUTION OF PLUTONIUM METAL AND THE ENTROPY OF Pu(III). Hinchey, Richard John. Lafayette, Ind., Purdue Univ., 1967. 112p. Thesis.

The heat of solution of high-purity, α-phase plutonium metal was measured at 25°C in 6 and 2 M hydrochloric acid as -139.4 ± 0.8 and 139.2 ± 0.8 Kcal/mole, respectively, in good agreement with recent, comparable measurements by others. The heat of solution of $PuCl_3 \cdot 6H_2O$(c) in water was measured as -8.056 ± 0.032 Kcal/mole at 25°C. From measurements of the solubility of the same salt and using estimates of the activity coefficients the entropy of Pu^{+3}(aq) was determined to be -47 ± 3 eu. Litera-

ture data were used to calculate the entropies of seven tripositive rare earth ions and yttrium. Deviations from a linear trend of the ionic entropy with crystal radius were accounted for precisely in terms of the calculated magnetic entropy of the ions. A consistent set of entropy values for the tripositive actinide ions was generated and values were calculated for the standard oxidation potentials of the M−M(III) couples for lanthanide and actinide elements. A solution microcalorimeter with very high sensitivity is described. (Disser. Abstr.)

4148 INTERNATIONAL SYMPOSIUM ON MACROMOLECULAR CHEMISTRY, PRAGUE, AUGUST 30–SEPTEMBER 4, 1965. PART 4. J. Polym. Sci., Part C, No. 16, 1857-2475 (1967). (CONF-650801–(Pt.4)).

There are 55 papers in the conference proceedings. Separate abstracts were prepared for 7 of these papers. (B.L.M.)

For abstracts of individual papers see: 4190–4196.

4149 DETERMINATION OF HEATS OF OXIDATION OF URANIUM SULPHIDES. Kolar, D.; Komac, M.; Drofenik, M.; Bohinc, M.; Marinkovic, V.; Vene, N. (Nuclear Inst. Jozef Stefan, Ljubljana, Yugoslavia). 12p. (CONF-670915–6). DTIE.

From Symposium on Thermodynamics of Nuclear Materials with Emphasis on Solution Systems, Vienna.

On the basis of DTA and x-ray measurements it may be concluded, that oxidation of uranium sulfides starts above 225°C. The main reaction, oxidation to UO_2, is finished below 400°C, at which some amount of U_3O_8 is present. At 500°C the only product present is U_3O_8. The heats of oxidation of US and US_2 to U_3O_8 were determined by the quantitative DTA method. The values found are: -276 ± 12 kcal/mol for US at 370°C and -345 ± 24 kcal/mol for US_2 at 356°C. (auth)

4150 CHEMISTRY OF NIOBIUM AND TANTALUM. Fairbrother, F. Topics in Inorganic and General Chemistry. Monograph 10. New York, American Elsevier Publishing Co., Inc., 1967. 250p. $17.50.

The following topics are considered: separation and extraction metallurgy; physical properties of metals; oxygen compounds; halogen compounds; hydrogen systems; carbon, silicon, and boron systems; nitrogen, phosphorus, arsenic, antimony, and bismuth systems; sulfur, selenium, and tellurium systems; and analytical chemistry. (M.C.G.)

4151 PROCESS AND APPARATUS FOR PREPARING OXIDE GEL MICROSPHERES FROM SOLS. (to United States Atomic Energy Commission). British Patent 1,087,890. Oct. 18, 1967. Priority date July 28, 1964, United States.

In a process for making actinide metal oxide gel microspheres from a stable hydrous sol containing at least one actinide metal oxide selected from thorium oxide, uranium oxide, and plutonium oxide, a stream of the sol and a surrounding stream of an organic liquid are introduced concurrently into a mass of the organic liquid maintained within a droplet-forming zone so that droplets of gel are formed, and the droplets are maintained in contact with the organic liquid so that the droplets are congealed and then recovered from the organic liquid. The sol has a pH of 2.0 to 4.5 and contains nitrate ions in a nitrate to actinide metal oxide molar ratio of 0.05 to 0.15. The organic liquid has an interfacial tension with water greater than 2 dynes/cm^2, and the solubility of water in the liquid at the temperature of the process is 0.3 to 10 vol %. The organic liquid also contains a surface active agent. The organic liquid is a primary alcohol having 6 to 8 carbon atoms. Carbon powder can be incorporated into the sol, and the microspheres of the congealed gel are dried and fired after removal from the organic liquid. The apparatus for carrying out the process is described in detail. (B.L.M.)

4152 HYPERFINE STRUCTURE OF MERCURY DEUTERIDE AND TRITIDE. Eakin, David Marshall. Berkeley, Calif., Univ. of California, 1966. 224p.

Thesis.

The spectra of the diatomic molecules HgD and HgT were produced, photographed, measured, and partially analyzed in the region 3300 to 4600 Å. The light source was an electrodeless discharge tube containing a small amount of Hg in a low pressure atmosphere of D_2 or T_2 plus Ar. A concave grating was used for the wavelength measurements, with interferometrically measured Th lines as standards. Safety precautions were necessary in working with the radioactive tritium. The hyperfine structure of ^{199}HgD and ^{199}HgT were studied in some detail using enriched Hg isotopes. The necessary resolution was obtained from a Fabry-Perot interferometer with cross-dispersion being provided by a plane grating spectrograph. The interferometer patterns were recorded photographically and the plates were measured on a semi-automatic comparator. The hyperfine splittings were measured for 416 lines in the 0-0, 0-1, and 0-2 bands of the A_1-X system of ^{199}HgD and for 302 lines in the 0-0, and 0-1 bands of the A_1-X system of ^{199}HgT. The results are similar to those already known for ^{199}HgH. A procedure was devised for obtaining absolute values of the hyperfine splittings in the energy levels from the observed splittings in the lines. The qualitative behavior of the splittings was compared with that predicted by the theory of magnetic hyperfine structure in diatomic molecules. The observed variations of the splittings with vibration, rotation, and isotopic form of the molecule seem to be accounted for by the theory, but detailed quantitative comparison is not possible due to the lack of exact knowledge of the molecular electronic wavefunctions. This investigation also produced, as an incidental result, a more complete analysis of the HgD spectrum than that previously published and the first rotational analysis of the HgT spectrum. With the aid of these analyses, two problems are discussed: the spin-splitting in the ground state and the variation of the molecular constants with the isotopic form of the molecule. It was found possible to give a theoretical explanation for the variation of the spin-splitting constant with vibration, rotation, and isotopic form. (Disser. Abstr.)

4153 PHYSICO-CHEMICAL STUDIES OF SOME SIX-, SEVEN-, AND EIGHT-COORDINATE ZIRCONIUM(IV) β-DIKETONATE COMPLEXES AND SOME EIGHT-COORDINATE β-DIKETONATE COMPLEXES OF HAFNIUM(IV), CERIUM(IV), AND THORIUM(IV). Pinnavaia, Thomas Joseph. Ithaca, N. Y., Cornell Univ., 1967. 120p.

Thesis.

A series of dihalo- and halozirconium(IV) acetylacetonate complexes of the type $Zr(acac)_2X_2$ (where X = Cl, Br) and $Zr(acac)_3X$ (where X = Cl, Br, I) were prepared and characterized. Only the chloro derivatives were known previously. The $Zr(acac)_2X_2$ complexes were obtained by reaction of the anhydrous zirconium(IV) halide with excess acetylacetone in diethyl ether at room temperature under anhydrous conditions. Analogous reactions in a suitable organic solvent at ca. 80°C yielded the $Zr(acac)_3X$ complexes (X = Cl, Br). Metathesis reaction of zirconium(IV) iodide and zirconium acetylacetonate, $Zr(acac)_4$, was found to be a superior method for synthesis of $Zr(acac)_3I$. No reaction was observed between zirconium(IV) fluoride and acetylacetone at 80°C. Attempts to prepare $Zr(acac)_3F$ by metathesis reaction of $Zr(acac)_3Cl$ and anhydrous AgF in absence of light in acetonitrile resulted in substitution of both chloride and acetylacetonate ligands. Attempts to prepare $Zr(acac)_2I_2$ by reaction of zirconium(IV) iodide with acetylacetone or $Zr(acac)_4$ yielded only $Zr(acac)_3I$. Complexes with X = Cl and Br are very weak electrolytes in nitrobenzene and are monomeric. The compound $Zr(acac)_3I$ is more highly ionized; the apparent degree of dissociation was estimated to be 0.25 at a concentration of 10^{-2} M in nitrobenzene and 0.1 at a concentration of 10^{-3} M in 1,2-dichloroethane. The ionic species of the iodide complex are markedly stabilized in presence of THF; the molar conductance was found to quadruple at a concentration of 10^{-3} M in 1,2-dichloroethane containing 0.05 M THF. Infrared spectra for the dihalo and halo complexes have been reported for the region 1800 to 250 cm^{-1}. The spectra, together with the molecular weight and conductance results indicate that the $Zr(acac)_2X_2$ complexes are six-coordinate and the $Zr(acac)_3X$ complexes are seven-coordinate. Most previous workers had assumed $Zr(acac)_3Cl$ to be six-coordinate. Infrared spectra of some eight-coordinated group IVb metal acetylacetonates, $M(acac)_4$ (M = Zr, Hf, Ce, Th), have also been reported. Two intense bands, one in the 450 to 422 cm^{-1} region and one in the 336-304 cm^{-1} region, for the six-, seven-, and eight-coordinated Zr complexes have been assigned to zirconium-oxygen stretching vibrations; both bands shift to lower energy as the coordination number of Zr increases. Metal-oxygen stretching vibrations were also assigned for $Hf(acac)_4$, $Ce(acac)_4$, and $Th(acac)_4$. The zirconium-chlorine stretching vibrations in $Zr(acac)_2Cl_2$ and $Zr(acac)_3Cl$ were assigned at frequencies coincident with the lower energy metal-oxygen stretching vibration. A band of medium intensity at 285 cm^{-1} in $Zr(acac)_2Br_2$ was tentatively assigned to a zirconium-bromine stretching vibration. X-ray powder patterns and microscopic analysis suggested that the halo and dihalo complexes are probably not isomorphous. Simple proton nmr spectra observed for solutions of the halo and dihalo complexes even at −108°C was attributed to very rapid rearrangement processes which average the environments of the various, expected, non-equivalent methyl protons in the molecules. The rapid ligand exchange of β-diketonate ligands which occurs upon mixing solutions of the eight coordinated group IVb metal acetylacetonates and the corresponding metal trifluoroacetylacetonates has been studied by fluorine nmr spectroscopy. The ligand exchange equilibria are described in terms of three independent equilibrium quotients. For the zirconium system, which has been studied in most detail, the equilibrium quotients in benzene and carbon tetrachloride solutions deviate by a factor of 2 to 3 from the values expected for a random statistical distribution of ligands. The mixed complexes $Zr(tfac)_3(acac)$, $Zr(tfac)_2(acac)_2$, and $Zr(tfac)(acac)_3$ are favored at the expense of $Zr(tfac)_4$ and $Zr(acac)_4$. De-

viations from a statistical distribution of ligands are due to entropy changes, which for the ligand exchange reactions are nearly zero. The nmr spectra also indicate that the group IVb β-diketones undergo very rapid isomerization. Attempts to detect geometrical isomers at temperatures as low as −105°C have been unsuccessful. Coalescence of nmr lines due to ligand exchange has been observed for mixtures of $Th(acac)_4$ and $Th(tfac)_4$. Extensive proton chemical shift data have been reported. The data have been interpreted in terms of the coordination number of the metal ion and in terms of dipole-indiced dipole solute-solvent interactions. Fluorine chemical shift data for the group IVb metal trifluoroacetylacetonates have also been reported. (Disser. Abstr.)

4154 KINETIC HYDROGEN ISOTOPE EFFECTS IN ELIMINATION REACTIONS OF ALICYCLIC AND ACYCLIC QUATERNARY AMMONIUM SALTS. Ashe, Thomas A. Rochester, N. Y., Univ. of Rochester, 1967. 157p.

Thesis.

In an attempt to further clarify the differences in E2 reactions of acyclic and alicyclic quaternary ammonium salts, a study of the primary H_2 kinetic isotope effect and relative rates was undertaken. As models for the alicyclic derivatives, cyclohexyl and cyclopentyl substrates were chosen to compare with the results for the acyclic derivative, 3-pentyltrimethylammonium salt. Stereospecifically deuterated trans-cyclohexyl-2-d-trimethylammonium, trans-cyclopentyl-2-d-trimethylammonium, and 3-pentyl-2,2-d_2-trimethylammonium p-toluenesulfonates were prepared. The base-induced decomposition of these salts enabled a determination of an intramolecular kinetic hydrogen isotope effect. The values were obtained by measuring the deuterium content in the olefin by mass spectrometry. In all base-solvent systems tried, the isotope effects were larger for the alicyclic derivatives than the acyclic substrate. The trends are consistent with an increase in carbanion character and a decrease in double bond character in the transition state in the order; cyclohexyl, cyclopentyl, 3-pentyl. Overall second order rate constants (k_2) for the decompositions were obtained by following the disappearance of base. A substitution reaction on the methyl group of the trimethylammonium group competed with the elimination reaction. The percentages of elimination and substitution were determined by analyzing the reaction mixture using vapor-phase chromatography These results enabled a calculation of the rate constants for elimination (k_E) and substitution (k_S). Cyclohexyltrimethylammonium underwent elimination at a slower rate, and substitution at a faster rate, than either the cyclopentyl or 3-pentyl derivatives. This result is explicable in terms of a conformation effect of the cyclohexane ring. The rate of elimination for cyclopentyl and 3-pentyl compounds could best be explained by use of both an inductive and steric argument. The E2 reaction of 3-pentyltrimethylammonium salts in all solvents gave a predominance of cis-2-pentene. This observation was interpreted as a consequence of the E1cb character in the transition state. The intramolecular kinetic H_2 isotope effect for the base-induced reaction of 3-pentyl-2,2-d_2 p-toluenesulfonate showed a regular trend of increasing value with increasing base strength. The predominance of cis-2-pentene observed only when t-BuOH is used as solvent is not easily explained as a consequence of E1cb character in the transition state. The regular trend in isotope effect suggests that the transition state is E1-like in character and the predominance of cis olefin is a result of a steric effect. (Disser. Abstr.)

4155 TOPICS IN SIGNIFICANT STRUCTURE THEORY OF LIQUIDS. PART I. SIGNIFICANT STRUCTURE THEORY OF ISOTOPE EFFECT. PART II. THE SIGNIFICANT STRUCTURE AND PROPERTIES OF LIQUID HYDRAZINE AND LIQUID DIBORANE. PART III. THE SIGNIFICANT STRUCTURE THEORY APPLIED TO THE HYDRIDES OF ELEMENTS OF THE FIFTH GROUP. Grosh, Joseph Walter. Salt Lake City, Univ. of Utah, 1967. 102p.

Thesis.

With the use of a simple visualized significant structure model of liquids, the isotopic vapor pressure differences of various liquids were successfully explained. It was noted that the vapor pressure differences are mainly affected by E_s, the heat of sublimation, but secondarily by molecular structure parameters such as the moment of inertia, I, and the mass of isotopic molecules, m. The results are shown in various pairs as H_2O-D_2O, H_2-D_2, NH_3-ND_3, $C_6H_6-C_6D_6$, $C_6H_{12}-C_6D_{12}$, $^{14}N_2-{}^{15}N_2$, and CH_4-CD_4. The calculated results are in excellent agreement with observed vapor-pressure differences. The significant structure theory of the liquid is further shown to be applicable to rocket fuels such as liquid hydrazine and liquid diborane over the entire liquid range. The following properties were calculated and were in good agreement with experimental values: vapor pressure, molar volume, entropy, the critical constants, heat capacity at constant volume and constant pressure, thermal coefficient of expansion, and compressibility. The surface tensions of the liquids were computed and the dielectric constant of the liquid hydrazine calculated according to previously published methods. Results showed good agreement with experimental observations. The significant structure theory was applied to the liquid state of PH_3, AsH_3, and SbH_3. The molar volume, vapor pressure, specific heat, entropy, and critical properties for the liquids are calculated. Surface tensions of the liquids calculated by a modification of earlier techniques are in good agreement with experimental observations. (Disser. Abstr.)

4156 SIGNIFICANT STRUCTURE THEORY. I. APPLIED TO LIQUID WATER AND HEAVY WATER. II. DIELECTRIC PROPERTIES OF LIQUID WATER AND VARIOUS FORMS OF ICE. III. ISOMERIC EFFECTS. Jhon, Mu Shik. Salt Lake City, Univ. of Utah, 1966. 81p.

Thesis.

In an attempt to explain some of the abnormal properties of H_2O and D_2O, the significant structure theory was used to calculate the thermodynamic and transport properties, and the theory gives maximum density at near 4°C for H_2O and at near 11.23°C for D_2O. The calculated results for entropy of vaporization, Helmholtz free energy, vapor pressure, molar volume, heat capacity, and the critical values are in good agreement with the observed values. The calculated curve for viscosity under pressure above 1 atm shows the observed minimum and is in satisfactory numerical agreement with the experimental values. A model assuming two species of solid-like molecules in equilibrium with liquid H_2O is proposed to explain the maximum density of H_2O at 4°C. The model demonstrates excellent agreement with experimental values and successfully explains the thermodynamic properties and the transport phenomena. The significant structure theory was applied to calculate the dielectric constants of light and heavy H_2O and various forms of ice. The Onsager's formula for polar liquid in terms of H-bonded structure and gas like degrees of freedom was modified. The theory shows better temperature dependence than any other theory for dielectric constants. The calculations between wide ranges of temperature showed excellent agreement with the experimental values. The theory of significant structure was further applied to p- and m-xylene over the entire liquid range. Assuming a transition occurs in the solids of both xylenes beginning at a temperature near the melting point, the theory successfully explains the large difference in the melting points and the near identity of such thermodynamic properties as the vapor pressure, molar volume, entropy of fusion, entropy of the liquid, critical constants, heat capacity at constant volume and constant pressure, thermal coefficient of expansion, and the compressibility. The viscosities of p- and m-xylenes were also calculated with good results. (TSS)

4157 MECHANISM OF THE FACILE ISOTOPIC EXCHANGE BETWEEN AN ORGANOMERCURIC HALIDE AND ELEMENTAL MERCURY. Walters, Edward Albert. Minneapolis, Univ. of Minnesota, 1966. 84p.

Thesis.

The isotopic exchange of mercury atoms between p-methoxyphenylmercuric halides and acetate and elemental mercury is first order in both substrate and surface area of mercury. The rate of exchange in benzene was independent of the stirring rate above 400 rpm; it was, however, a function of stirring rate at lower stirring speeds. At the higher stirring rates the reaction rate was a function of both the substrate structure and the solvent. It was concluded from this that, for higher rates of stirring, exchange is not controlled by a transport process, but by a chemical step. A calculation supported the conclusion that self-diffusion of mercury is not the slow step. Although the exchange rate was studied in solvents ranging from water to isooctane the maximum ratio of rates obtainable with the same substrate was 47. A variety of species with catalytic or inhibiting potential did not alter the rate significantly. The experiments demonstrated that exchange was occurring in the vicinity of the liquid–liquid interface and that transition state and ground state are quite similar. The ground state solvent shell seemed to be nearly intact when the transition state was achieved. The substituent effects observed with p-methoxyphenylmercuric halides and acetate gave the order of reactivity, I > Br > Cl > OAc. This observation, along with previously reported effects of substituents in the ring, suggests that the slow step is transfer of an electron either from the aromatic portion of the molecule or the mercury atom to metallic mercury. The rate of exchange was found to be sensitive to agitation of the mercury droplet. This is consistent with an inhomogeneous surface, having both active and inactive sites. The enthalpy of activation was 8.09 ± 0.60 kcal $mole^{-1}$ and the activation entropy was −44.8 ± 0.5 cal $mole^{-1}$ deg^{-1}, both determined in the usual way, in toluene as a solvent, from seven rate constants in range 0 to 40°C. A mechanism that can accommodate the observations is proposed. The possible inhomogeneity of the mercury surface is discussed in

terms of structural defects. The solubility of p-methoxyphenylmercuric bromide in a variety of solvents was measured. The heat and entropy of solution in toluene was obtained from a study of the temperature dependence of solubility. (Disser. Abstr.)

4158 SECONDARY β-DEUTERIUM ISOTOPE EFFECTS IN THE FORMATION OF AMMONIUM AND PHOSPHONIUM SALTS. Kaplan, Elizabeth Dee. Philadelphia, Univ. of Pennsylvania, 1966. 184p.

Thesis.

Study of secondary β-deuterium isotope effects in the formation of ammonium and phosphonium salts was undertaken with the hope of clarifying the steric and electronic changes occurring within the molecules during reaction that lead to the force constant changes responsible for these effects. The rates of reaction in nitrobenzene at 51.29 ± 0.005°C of methyl tosylate with N,N-dimethylaniline and N,N-dimethyl-$\underline{d}_6$-aniline to form trimethyl- and methyl-dimethyl-$\underline{d}_6$-phenyl ammonium tosylate, respectively, and with dimethylphenylphosphine and dimethyl-$\underline{d}_6$-phenylphosphine to form the corresponding phosphonium salts (respectively), were determined conductiometrically by following the increase in the product concentration with time. Calibration curves were constructed to establish the relationship between conductivity and salt concentration. A non-linear relationship necessitated the conversion of all conductivity readings to product concentrations. The latter were then used as input data for a generalized non-linear least squares program that calculated the pseudo first-order rate constants, which were then converted to second-order constants using the appropriate factor. The secondary isotope effects observed were small and inverse: 1.133 ± 0.008 for the amines, and 1.050 ± 0.002 for the phosphines. The result for the amines is discussed in relation to the equilibrium isotope effect(s) calculated using the information obtained from the observed infrared spectra of the reactants and products. Due to uncertainties in assigning spectral bands, three different assignment sets were made, and an equilibrium isotope effect (from zero-point energy differences only) was calculated for each. Only one set of vibrational frequencies yielded what was thought to be a reasonable result, although some of the frequency assignments were probably in error. It was found, from the spectra observed, that the shifts for the C–H and C–D stretching frequencies contribute to a normal isotope effect (K_D/K_H = 0.7558), although the frequencies appear to increase on going from reactant to product. This is attributed to coupling of the stretching modes with lower frequencies in both reactant and product, but more extensively in the former than in the latter, and to a greater degree for C–D than for C–H stretching. This leads to a net loss in zero-point energy even while the force constants increase. The inverse effect observed is therefore, due to increased force constants for the lower vibrations. This interpretation is consistent with a steric explanation for the isotope effect. A very reactant-like transition state would also lead to a small effect, but a net increase in the force constants must still occur in order for the effect to be inverse. The isotope effect for the phosphines is discussed with respect to the steric requirement for this system as compared with the amine system. Less steric crowding and the possibility of $\underline{d}$-orbital overlap with the methyl groups (hyperconjugation) in the transition state lead to the expectation of a smaller inverse effect for the phosphines than for the amines; this is observed experimentally. (Disser. Abstr.)

4159 APPARATUS FOR THE PRODUCTION AND PURIFICATION OF A SUBLIMABLE SUBSTANCE. Joly, Michel; Lecocq, Alfred; Rigaud, Andre (to Commissariat a l'Energie Atomique). British Patent 1,091,694. Nov. 22, 1967. Priority date Oct. 7, 1964, France.

An apparatus for the production of sublimable substance by chemical reaction between a solid and a gas includes a tubular chamber consisting of a first part provided with heating means and including an inlet duct for a reactive gas and a system for introducing a solid into a boat in which the reaction is carried out. The chamber also includes a second part made up of a condensation surface for the sublimate, outlet ducts for the reaction gases, and a discharge duct for the condensed product. The condensation surface consists of a tube through which a liquid refrigerant flows, and the tube is connected to a vibrator to detach the solid particles condensed on its surface. (B.L.M.)

4160 SINGLE-STEP PROCESS FOR PREPARATION OF URANIUM DIOXIDE FROM URANIUM HEXAFLUORIDE. (to United States Atomic Energy Commission). British Patent 1,091,486. Nov. 15, 1967. Priority date Nov. 19, 1964, United States.

A process for converting UF_6 to very pure UO_2 consists of contracting the UF_6 with a gaseous mixture of H_2 and either gaseous O_2 or H_2O vapor at a temperature above 1100°C and a pressure not exceeding 20 torr. The gaseous mixture should contain a stoichiometric excess of H_2 and O_2 or H_2O vapor. (B.L.M.)

4161 STUDY OF THE URANIUM–OXYGEN–SULFUR SYSTEM USING SOLID STATE GALVANIC CELLS. Yuill, William Alexander Jr. Iowa City, Iowa, Iowa Univ., 1967. 71p.

Thesis.

Solid-state galvanic cells were used to determine the partial pressure of oxygen over the three phase mixture uranium monosulfide, uranium oxysulfide, and uranium dioxide in the temperature range 1050 to 1350°K. Two cells used to complete the study were Ta, Ta_2O_5//US, UOS, UO_2 and Nb, NbO//US, UOS, UO_2. The emf of the cell Ta, Ta_2O_5//US, UOS, UO_2 between 1149 and 1350°K is given by E(mv) = (1.360 ± 0.037) × 10^3 – (0.942 ± 0.029)T. The partial pressure of oxygen calculated from the cell voltage is given by the equation log Po_2 = –14,690/T – 10,490. The electrolyte used for this experiment was either 0.99 ThO_2 · 0.01 La_2O_3 or 0.95 ThO_3 · 0.07 Y_2O_3. A discussion of the experimental equipment and procedures is included. A brief discussion of the theory of solid state galvanic cells and a discussion of the results are also included. (Diss. Abstr.)

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Refer also to abstracts 4014, 4135, 4237, 4404, 4405, and 5809.

4162 (RCC-R-208) RADIATION INDUCED EXCHANGE BETWEEN IODIDE AND PARA-IODOBENZOATE IN AQUEOUS SOLUTION. Appleby, A.; Spillett, R. E. (Radiochemical Centre, Amersham (England)). July 1967. 25p. Dep. CFSTI. UK 4s. 0d.

A new radioinduced exchange reaction between p-iodobenzoic acid and iodide ion in aqueous solution is described. A free-radical mechanism, consistent with the experimental data, is postulated, and possible further experiments to test the mechanism are discussed. The practical value of the reaction for the preparation of labelled iodoaromatic compounds is discussed. Modifications designed to yield a product of higher specific activity are suggested. (auth) (UK)

4163 USES OF HIGH-ENERGY RADIATION FOR THE MODIFICATION OF TEXTILE FIBERS. (A REVIEW OF THE LITERATURE 1963–1966). Gilbert, R. D.; Stannett, V. (North Carolina State Univ., Raleigh). Isotop. Radiat. Technol., 4: 403–25(Summer 1967).

The literature from January 1963 to August 1966 on the use of radiation to modify textile fibers is reviewed. Degradation, cross-linking, and graft copolymerization are discussed, with emphasis on the use of graft copolymerization to modify properties of polyamide, polyester, celluosic, polyolefin, wool, and silk textile fibers. Some related ESR studies are also presented. (auth)

4164 SOLID-STATE POLYMERIZATION STUDIES. I. 2-VINYLNAPHTHALENE POST-POLYMERIZATION INITIATED BY ^{60}Co γ IRRADIATION. Parrish, C. F.; Trinler, W. A.; Burton, C. K. (Indiana State Univ., Terre Haute). J. Polym. Sci., Part A-1, 5: 2557-62(Oct. 1967).

^{60}Co γ-irradiated 2-vinylnaphthalene was observed to post-polymerize in the solid phase. Plots of conversion versus time indicated a 14% limiting conversion of monomer to polymer. The post-polymerization was found to be first-order in monomer with an Arrhenius activation energy of 19.0 kcal/mole. (auth)

4165 REACTIVITIES OF THE FREE RADICALS FORMED IN HIGH POLYMERS. A CLASSIFICATION OF HIGH POLYMERS. Ueda, Hisashi; Shida, Shoji (Tokyo Inst. of Tech.). Kogyo Kagaku Zasshi, 69: 1527-9(Aug. 1966). (In Japanese).

Stable free radicals are formed in most of irradiated organic high polymers at or near 20°C. A molecule-to-molecule mixing of a high polymer with a gas is possible. Some reactions, therefore, can take place between the free radicals formed in a high polymer by irradiation and the gas that was mixed with it prior to irradiation. Free radical reactions can also take place if a gas is in contact with a pre-irradiated high polymer. The reaction products from these two processes are generally different. The radical transformation process will interpret this difference. A classification of high polymers was tried according to the types of radical transformations that were observed in high polymers. Observations of these phenomena were made by the ESR method. Polytetrafluoroethylene, polymethylmethacrylate, and some other polymers belong to a special group in this classification. The special characteristics of these polymers can be explained if a longer lifetime of the ion-radicals formed in these high polymers is assumed. (NSA of Japan)

4166 RADIOINDUCED TELOMERIZATION AND POLYMERIZATION OF ETHYLENE IN ALCOHOLS. Machi, Sueo; Kise, Seiichi (Japan Atomic Energy Research Inst.). Kogyo Kagaku Zasshi, 69: 1892-6(Sept. 1966). (In Japanese).

Telomerization and polymerization of ethylene in methanol induced by γ radiation were carried out under high pressure of 100 to 400 kg/cm^2 at 40 to 170°C with the dose rate of 6.3 × 10^4 to 3.0 ×

10^5 RAD/hr in a batch reactor of 100 ml capacity. The telomer formed was found to be a higher alcohol having a primary OH group and an odd number of carbon atoms. The average degree of polymerization of the telomer was 10 to 30. The solid polymer was also found to have a primary OH group. The rate of reaction of ethylene in methanol was found to be proportional to the initial pressure and to dose rate 0.6. An apparent overall activation energy was about 4 kcal/mol. The ratio of the telomer yield to the total yield increased with the reaction temperature, and was 90 wt. % at 170°C at 400 kg/cm². When butanol and 2-propanol were used as telogens instead of methanol, secondary and tertiary higher alcohols were mainly obtained. The initiation reaction rate in methanol was about ten times as high as that for plain ethylene, and the rates in butanol and 2-propanol were higher than in methanol. (NSA of Japan)

4167 EFFECT OF SOLVENT ON THE γ-RADIO-INDUCED POLYMERIZATION OF ETHYLENE. Machi, Sueo; Fujioka, Shuji (Japan Atomic Energy Research Inst.). Kogyo Kagaku Zasshi, 70: 388-90(Mar. 1967). (In Japanese).

The effects of solvent on the rate of polymerization and the degree of polymerization were studied in the radiation polymerization of ethylene under high pressure. The polymerization was carried out in the stainless steel (SUS-27) high pressure vessel of 100 ml capacity under the condition of 300 kg/cm², 24 to 26°C and 2.5×10^4 RAD/hr. When using methanol, ethyl ether, and ethyl acetate as solvent, the rate of polymerization was relatively large, i.e., 1 to 5 g polymer/l hr. When n-hexane, toluene, and xylene were used, the rate was rather small, i.e., 0.05 to 0.2 g polymer/l hr. Solvent with high value of G_R (G-value of radical formation) gave a high rate of polymerization, and solvents with low G_R-value gave a low polymerization rate. These facts are consistent if an initiating radical is formed from the solvent and monomer, and the rate constants of these reactions are proportional to the G-values of the solvent and monomer. (NSA of Japan)

4168 RADIATION-INDUCED POLYMERIZATION OF 1,1,2-TRICHLOROBUTADIENE. Matsuda, Tatsuo; Fujii, Shigetada (Government Industrial Research Inst., Nagoya, Japan). J. Polym. Sci., Part A-1, 5: 2617-27(Oct. 1967).

The γ-induced polymerization of 1,1,2-trichlorobutadiene, m.p. −48.5°C, was investigated in the temperature range from +55 to −196°C. In the liquid state, the following results were obtained: the rate decreased with decrease of temperature (E_a = 8.0 kcal/mole); the dose rate dependences of rate and of molecular weight were 0.49 and −0.25, respectively; the reaction was inhibited by DPPH; and the structure of the polymer was predominantly 1,4 units. It was concluded that the liquid-state polymerization proceeds by a radical mechanism, and the radical yield was found to be 19.7. In the solid state, the following results were obtained: the rate was considerably higher than in the liquid state immediately above the melting point and gradually decreased with decrease of temperature (E_a = 0.34 kcal/mole); the dependence of the rate on dose rate was unity while the molecular weight was independent of the dose rate; the reaction rate was unaffected by DPPH and accelerated by dimethylformamide; and the structure of the polymer, 3,4 units, was completely different from that of the polymer obtained in the liquid-state polymerization. The solid-state polymerization is probably of a different nature and is not well elucidated. (auth)

4169 EFFECT OF ANNEALING ON THE RADIATION DEFECTS IN MONOCRYSTALS OF ZnS. Putiev, I. T.; Gavrilov, F. F.; Bezel', V. S.; Chirkov, A. P. (Ural Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 8, 154-6(1967). (In Russian).

Single crystals of ZnS were irradiated with neutrons at an integral dose of 10^{18} neutrons/cm². The optical density of the crystals was measured at room temperature, and the absorption spectrum of the color centers was obtained. The crystals were then annealed and typical annealing curves are illustrated. These indicate that at a temperature of ~240°C the annealing process begins slowly. At higher temperatures the annealing proceeds rapidly and at ~380°C the crystal is practically bleached. The dependence of the optical density on the annealing time at different temperatures is illustrated. The results indicated that the annealing process occurs in two steps with different activation energies. (J.S.R.)

4170 TEMPERATURE DEPENDENCE OF LITHIUM FLUORIDE RADIOLUMINESCENCE YIELD AND EMISSION SPECTRA. Shvarts, K. K.; Aluker, E. D.; Intenberg, L. E.; Chernov, S. A. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 4, 51-4(1967). (In Russian).

Temperature dependence of lithium fluoride radioluminescence under excited reactor radiation and the luminescence spectra under pulsed electron excitation are considered. The luminescence spectra and the luminescence kinetics were found to depend on temperature and excitation density. (auth)

4171 RADIATION INDUCED COPOLYMERIZATION OF ISOBUTENE AND SULFUR DIOXIDE. Ito, Masayuki; Kuri, Zenichiro (Nagoya Univ., Japan). Kogyo Kagaku Zasshi, 69: 2009-11(Oct. 1966). (In Japanese).

Radioinduced copolymerization of isobutene with SO_2 was carried out. In the liquid state at −78°C, the yield increased with increasing amounts of SO_2 in the reaction mixtures, and was proportional to the power of 0.75 of dose rate. The monomer ratio of the obtained polysulfone was about 1/1, and the maximum value for the rate of polymerization was at about −60°C. The reaction mechanism is supposed to be due to free radicals. In solid-state polymerization, post polymerization was observed. The monomer ratio of the polysulfone obtained at −196°C was isobutene/SO_2 = 3/2. In phase diagram of this system, a compound (isobutene/SO_2 = 2/1) was observed. (NSA of Japan)

4172 COMPARISON OF DEGRADATION RATES OF SANTOWAX OM AND SANTOWAX WR. Mason, E. A.; Lee, Min-li; Bley, W. N. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 10: 480(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4173 HOT ATOM CHEMISTRY OF GAS-PHASE SYSTEMS. Wolfgang, Richard (Yale Univ., New Haven). Progr. React. Kinet., 3: 97-169(1965).

A critical appraisal of results, ideas, models, and problems at the present early stage of development of hot-atom chemistry is presented. Topics discussed include: techniques for the production of hot atoms; identification of hot processes; kinetic theory of hot reactions; hot atom reactions of hydrogen; hot atom reactions of halogens; and hot atom chemistry of carbon. (162 references) (D.H.M.)

4174 PULSE RADIOLYSIS. Dorfman, Leon M.; Matheson, Max S. (Argonne National Lab., Ill.). Progr. React. Kinet., 3: 237-301(1965).

A summary of current research in pulse radiolysis, defined as including all experiments in which a transient species produced by a pulse of ionizing radiation is directly observed by means of one of its properties, e.g., optical absorption spectrum, ESR absorption spectrum, or electric conductivity, is presented. Various aspects of the experimental method are discussed. The published rate constants measured by this method are tabulated. (165 references) (D.H.M.)

4175 DOSE-RATE AND LINEAR ENERGY TRANSFER EFFECTS IN RADIATION CHEMISTRY. Burns, W. G.; Barker, R. (Atomic Energy Research Establishment, Harwell, Eng.). Progr. React. Kinet., 3: 303-68(1965).

A correlation is presented of the information available on the dose-rate and linear energy transfer (LET) effects in the radiation chemistry of non-aqueous systems (principally liquids) with the diffusion model. LET is the differential rate of loss of energy per unit length of the track of an ionizing particle. The review covers the theoretical aspects, the dose rate and LET effects in the radiation chemistry of various compounds, and work with scavengers. (131 references) (D.H.M.)

4176 γ-RADIOLYSIS AND PHOTOLYSIS OF α-DIAZOACETOPHENONE IN VARIOUS SOLVENTS. Yukawa, Yasuhide; Ibata, Toshikazu (Osaka Univ.). Nippon Kagaku Zasshi, 88: 1223-8 (Nov. 1967). (In Japanese).

α-Diazoacetophenone was reported to give the phenylacetic acid derivatives through the corresponding ketene intermediate by the thermal, photochemical, and catalytic Wolff rearrangements. The propriety of the free radical chain mechanism of the catalytic Wolff rearrangement of diazoketones proposed by Newman and Beal was investigated. The difference of the γ-radiolysis from the photolysis of diazoketones was also studied. The reactions were carried out in the atmosphere of inert gas and/or oxygen using various solvents such as alcohols, benzene, carbon tetrachloride, bromoform, thiophenol, and some of their mixed solvents. No rearranged product was obtained by means of the γ-radiolysis under any experimental conditions available to produce the free radical intermediates, which was indicated in the Newman's mechanism. In the atmosphere of oxygen the formation of benzoic acid was recognized independently of the solvents used. The γ-radiolysis of diazoketone in carbon tetrachloride or bromoform solution afforded the corresponding phenacyl halides in considerable yields, in the same manner as the case where the photolysis was carried out using the same solvents. The formation of triethylamine hydrochloride by the γ-radiolysis of diazoketone in carbon tetrachloride solution in the presence of triethylamine shows that the formation of phenacyl halides seems to be caused by the reaction of diazoketone with hydrogen halides generated by the decomposition of the halogen-containing solvents used. These results seem to raise some questions about Newman's free radical chain mechanism of the Wolff rearrangement catalyzed by silver benzoate. (auth)

4177 ON THE RADIATION-INDUCED POLYMERIZATION OF ISOBUTYLENE UNDER ANHYDROUS CONDITIONS AND THE EFFECT OF SOLID ADDITIVES. Taylor, Robert B.; Williams, Ffrancon (Univ. of Tennessee, Knoxville). J. Am. Chem. Soc., 89: 6359-60(Nov. 22, 1967). (ORO-2968-26).

The radioinduced ionic polymerization of extremely dry isobutylene was studied in order to determine the effect of solid additives on polymerization rate. The addition of solid zinc oxide did not affect the polymerization rate markedly. Results confirmed the limitation of radioinduced ionic polymerization by residual water content. (J.G.B.)

4178 PHOTOCONDUCTION OF HIGH-DENSITY POLYETHYLENE. Tanaka, Toshikatsu (Central Research Inst. of Electric Power Industry, Tokyo); Inuishi, Yoshio. Jap. J. Appl. Phys., 6: 1371-80(Dec. 1967).

A photo-current was observed in high-density polyethylene when a 40 micron-thick sample was exposed to low-intensity white light from a tungsten lamp. A large photo-current was found when a sample had been pre-irradiated with high-energy electrons. The polyethylene was fairly sensitive to photons with a certain range of energy (about 1.2 eV), and had approximately the same activation energy as the dark current. Photo-current/light-intensity characteristics were divided into three regions of intensity. A tentative energy diagram is proposed for irradiated polyethylene on the assumption of the band model. (auth)

4179 THE INFLUENCE OF AGITATION ON THE GAS-PHASE ETHYLENE POLYMERIZATION INDUCED BY γ-RAYS. Kawakami, Waichiro; Hagiwara, Miyuki; Hosaki, Yoshihiko, Machi, Sueo; Kagiya, Tsutomu (Japan Atomic Energy Research Inst., Takasaki). Bull. Chem. Soc. Jap., 40: 2668-75(1967).

Effects of agitation on the γ-radioinduced polymerization of ethylene were studied in a gaseous system at a pressure of 400 kg/cm^2 and at a temperature of 30°C, with dose rates ranging from 9.0×10^2 to 3.8×10^3 RAD/hr. Both the rate and the degree of polymerization decreased upon agitation to ca 50% of those in the polymerization without agitation. The kinetic analysis of the experimental results indicated that this decrease in the rate and in the degree of polymerization is mainly due to a decrease in the absolute propagation rate. Further, it was found that agitation had no effect on initiation and transfer reactions. The termination was not effected by agitation under a high dose rate, but it was slightly promoted at lower dose rates. (auth)

4180 THE ELECTRON SPIN RESONANCE OF γ-IRRADIATED SODIUM POLYPHOSPHATE. II. EFFECTS OF THE DEGREE OF POLYMERIZATION AND THE KIND OF CATION. Hasegawa, Akinori; Miura, Masaji (Hiroshima Univ.). Bull. Chem. Soc. Jap., 40: 2553-8(1967).

Sodium polyphosphate irradiated with γ rays was investigated with ESR by varying the degree of polymerization and by replacing sodium ion with other cations. By irradiating at room and liquid nitrogen temperatures and observing ESR at various temperatures, nine kinds of paramagnetic centers were detected. Two of them were attributed to trapped electrons and the others to trapped holes. Four of the latter groups were assigned to radicals on polyphosphate: fragments by bond rupture, $-O_2PO_3^{\cdot}$ and $\cdot PO_3^{-}$, radical on end group, $-O_2PO_3^{\cdot}$, and radical on chain, $-O_2\dot{P}OO-$. (auth)

4181 SILENT DISCHARGE REACTIONS IN AQUEOUS SOLUTIONS. VII. ALKALINE AQUEOUS SOLUTION OF POTASSIUM FERRICYANIDE IN ATMOSPHERES OF HELIUM AND ARGON. Yokohata, Akira; Tsuda, Satoru (Hiroshima Univ.). Bull. Chem. Soc. Jap., 40: 2507-11(1967).

Studies on silent discharge reactions of aqueous solutions were extended to an alkaline region. Potassium ferricyanide was selected as the reaction medium. The situation was very similar to that in the case of radiation chemistry. The G value of the disappearance of ferricyanide ions was almost the same as that of cerous ions formed from the acidified ceric solution by silent discharge reaction under the same experimental condition. Moreover, the yield of hydrogen peroxide produced in the alkaline solution was almost the same as those of acidic and neutral solutions. Those findings suggest that the radical yields will be almost equal, irrespective of pH in the range studied. Further evidence showed that most of silent discharge reactions of the aqueous solutions in inert gases can be well interpreted in terms of the radiolysis by slow electrons generated in the gas phase. (auth)

4182 RADIOINDUCED GRAFT COPOLYMERIZATION OF STYRENE TO POLYETHYLENE SINGLE CRYSTAL AGGREGATE FILMS. RELATION BETWEEN POLYMER RADICALS AND GRAFTING EFFICIENCY. Takamatsu, Toshiaki; Kaibara, Makoto (Inst. Phys. and Chem. Research, Tokyo). Rika Gaku Kenkyusho Hokoku, 42: No. 6, 231-7(Nov. 1966). (In Japanese).

High-density polyethylene single crystal aggregate films were prepared by crystallizing the polymer in dilute xylene solution, and heat treating for 24 hours at 100 to 121°C in a vacuum. The films were irradiated in the vacuum with ^{60}Co gamma rays (1.2×10^5 r/hr) to a dose of 1.4×10^7 R and the free radicals in the irradiated films were examined by the ESR technique. Immediately after the irradiation, free radicals of alkyl types predominated; these then disappeared rapidly leaving only free radicals of allyl types. An anisotropy was observed in the ESR spectrum of these free radicals. The life times of the free radicals in the irradiated aggregate films were longer than those of ordinary high- or low-density polyethylene films. Heat treatment of the films at above 120°C before irradiation gave higher densities of the free radicals. This is explained by the thickening of lamella layers and consequently the longer time required for the free radicals to migrate from inside the single crystals to the surface along the polymer chains. When stable long-lived free radicals in the irradiated films were brought into contact with styrene monomer, 30 to 40% disappeared rapidly and graft copolymerization took place. Heat treatment of the films had no effect on the decreasing velocity of the free radicals in the initial stage; but a lower decreasing velocity resulted for the free radicals of balance (60 to 70%) by the treatment. It was concluded that the rapidly disappearing free radicals lie on or near the surface of the single crystals, while the more stable free radicals lie inside the single crystals, taking a longer time to migrate on to the surface and to react there with the monomer molecules. (NSA of Japan)

4183 ON THE CHEMICAL FORMS OF ^{14}C PRODUCED BY THE REACTION ^{14}N(n,p)^{14}C IN BERYLLIUM, MAGNESIUM, CALCIUM, ALUMINUM, AND ZIRCONIUM NITRIDES. Kuhry, J.-G.; Adloff, J.-P. (Centre de Recherches Nucleaires, Strasbourg). Bull. Soc. Chim. Fr., No. 9, 3414-18(Sept. 1967). (In French).

After dissolution of the irradiated targets in various diluted acids or alkalis, the chemical forms of ^{14}C were analyzed in the gaseous fraction and in the solution. The volatile compounds were separated by radio gas chromatography. Chemical separations with carriers were achieved for the products that remained in the liquid phase. The whole ^{14}C activity was found to be distributed among four compounds: CH_4, CO_2, HCN, $CN-NH_2$. The results are explained by hot replacement collisions between recoiling ^{14}C and atoms of the lattice. (auth)

4184 SILENT DISCHARGE REACTIONS IN AQUEOUS SOLUTIONS. VI. AQUEOUS SOLUTION OF CHLORALHYDRATE IN ATMOSPHERES OF HELIUM AND ARGON. Yokohata, Akira; Tsuda, Satoru (Hiroshima Univ.). Bull. Chem. Soc. Jap., 40: 2502-7(1967).

Research on reaction systems hitherto limited to acidic solutions was extended to include neutral solutions. Silent discharge led to production of hydrochloric acid from neutral aqueous chloralhydrate. A linear correlation was observed between yield of hydrochloric acid and electric discharge current. This finding was successfully interpreted in terms of absorbed dose, the value of which can be estimated at a given electric discharge current. Yields of hydrochloric acid were not significantly affected by chloralhydrate concentration between 1×10^{-2} and 1×10^{-3} M. The experiments of the radical scavenging effect of cupric ion and bromide ion showed that $K_{H+Cu^{2+}}/K_{H+CCl_3CH(OH)_2} \approx 0.2$ and $K_{OH+Br^-}/K_{OH+CCl_3CH(OH)_2} \approx 9$, and also that the following formula holds approximately irrespective of kind of gas used in low solute concentration and dose rate used: values of hydrogen atom G(HCl) ≃ 3G(OH) + G(H). Moreover, these findings also suggested that the G values of and hydroxyl radical obtained in the acidic aqueous solution can be applied approximately to the neutral region. The relation of G(HCl) to solute concentration was qualitatively identical to gamma irradiation, although they were different in detail because of the difference in value of LET and in the mechanism of radical formation. (auth)

4185 PRODUCTION OF ^{128}I BY SMALL RESEARCH REACTOR. Maruyama, Yoshiaki; Idenawa, Kazuhide (Musashi Inst. of Tech., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo), 4: 565-9(Nov. 1967).

A study was conducted on the preparation of a high-specific-activity ^{128}I utilizing hot atom effects. Crystalline iodine pentoxide, ammonium iodate, and iodic acid were irradiated in the pneumatic tube and the rotary rack of a TRIGA-II reactor. Variation of the ^{128}I retention with duration of irradiation and with neutron beam intensity was determined. The retention of ^{128}I in the iodate fractions increased during the first 30 min, after which it stabilized. Ammonium iodate showed the lowest for ^{128}I retention. The retention generally increased with neutron beam intensity. The specific activity of ^{128}I was determined from the amount of iodine simultaneously produced by decomposition of the samples by radiation. The radiation decomposition increased linearly with irradiation time. Ammonium iodate decomposed much more than iodine pentoxide and iodic acid. The enrichment factors of ^{128}I were calculated on the basis of the results obtained from these experiments. Ammonium iodate showed the highest enrichment factor. Con-

sequently, a high specific activity ^{128}I was prepared by irradiating 500 mg of ammonium iodate for 30 min in pneumatic tube. The resulting enrichment factor of ^{128}I was 1.3×10^4. Active impurities in the product were found to be less than 1 ppM. (auth)

4186 RADIATION-INDUCED CHAIN POLYMERIZATION AT 4.2°K. Gerasimov, G. N.; Bruk, M. A.; Gromov, V. F.; Abkin, A. D.; Khomikovskii, P. M.; Matveeva, A. V.; Chernyak, I. V. (Inst. of Physics and Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 174: 386-9(May 11, 1967). (In Russian).

After taking special precautions to free the monomers from water and air, tetrafluorethylene and acrylonitrile were polymerized by irradiation with gamma rays at a dose rate of 0.25×10^6 RADS/hr. Vinyl acetate was irradiated at a dose rate of 3.2×10^6 RAD/hr. The polymer yield was determined gravimetrically, and the molecular weight of the polymer was obtained by solution viscosity studies. It was shown previously that polymerization of these monomers at 77°K takes place directly during irradiation in the solid state. Hence the results were compared at 77 and at 4.2°K. The initial rate of polymerization did not change on decreasing the irradiation temperature from 77 to 4.2°K. The polymer yield at high doses ($>1 \times 10^6$ RAD) decreased on lowering the temperature from 77 to 4.2°K with polymerization of acrylonitrile and crystalline vinyl acetate. The polymer yields of glassy vinyl acetate and of tetrafluoroethylene did not decrease with decreasing temperature. The molecular weights of vinyl acetate and acrylonitrile polymers did not depend on irradiation temperature, but the molecular weight of the acrylonitrile polymer exceeded by an order of magnitude the molecular weight of the polymer formed in the liquid state at −78°C. These results indicated that thermal motion in a solid monomer is not a necessary condition for growth of a polymer chain during irradiation. (TTT)

4187 OBSERVATIONS OF PHOSPHORESCENCE IN PLASTIC SCINTILLATORS EXCITED BY ^{60}Co γ IRRADIATION. Kropp, John L. (TRW Systems, Redondo Beach, Calif.). J. Chem. Phys., 47: 3340-7(Nov. 1, 1967).

The γ-induced luminescence of chrysene-d_{12}, coronene-d_{12}, and p-terphenyl was studied in plastic hosts (DER-332 and polymethylmethacrylate). Both phosphorescence and fluorescence were observed. The variation of phosphorescence and fluorescence as a function of solute concentration was determined. From the concentration dependence, Q parameters can be calculated for the phosphorescence (Q_P) and fluorescence (Q_F) of the compounds studied. The ratio of phosphorescence to fluorescence under γ irradiation (R_γ) was compared to that observed under uv irradiation (R_{uv}) and a kinetic scheme developed that relates (R_γ/R_{uv}) to Q_P and Q_F assuming only excitation transfer. From the fit of the kinetic treatment to the experimental points, it was concluded that triplet coronene-d_{12} is formed mainly via excited solvent triplets. Triplet p-terphenyl was not formed via excited solvent but by other processes probably involving ions. (auth)

4188 SCINTILLATION STUDIES OF ORGANIC COMPOUNDS IN A SUPERCOOLED MOLTEN STATE. Horrocks, Donald L.; Wirth, Hermann O. (Argonne National Lab., Ill.). J. Chem. Phys., 47: 3241-7(Nov. 1, 1967).

When the crystals (obtained by crystallization from certain solvents) of a number of low-molecular-weight organic compounds (11 derivatives of 2-phenylindole and two derivatives of p-quaterphenyl) were melted and recooled to room temperature, rather stable nonrecrystallizing, supercooled melts were obtained. The consistency of these at room temperature varied from rather viscous oils to rigid glasslike masses. Their stability also varied over a wide range; from one day to at least several years. The response of these amorphous, pure scintillators to excitation by energetic electrons was measured relative to a standard liquid scintillator solution (gas-free, 3-g/liter PPO–toluene solution), which was assigned a value of 100. The very stable (at least several years) and rather rigid melt of 1^2, 2^3, 3^2, 4^3-tetramethyl-p-quaterphenyl exhibited a relative response of 92. The supercooled melt of N-isoamyl-3,2'-ethyleno-2-phenylindole showed a relative response of 125 and remained amorphous with a consistency at room temperature of a thick grease for greater than nine months if maintained under evacuated conditions. The fluorescence spectra of these compounds in the undiluted, supercooled state and in a toluene solution (mole fraction of about 0.001) were measured for excitation by 315-mμ radiation. In some cases there were differences in the measured spectra depending on the type of sample. (auth)

4189 RADIATION CHEMISTRY IN JAPAN. Tabata, Yoneho (Tokyo Univ.). Chim. Ind. Genie Chim., 97: 980-6(Apr. 1967). (In French).

The history of radiation chemistry in Japan is described briefly. The present status of studies in Japan is given. The arrangement of the Japan Atomic Energy Research Institute at Takasaki is illustrated. The work of Hirota at Osaka in prediction of mass spectral cleavage pattern from MO theory, liquid-phase-radiolysis studies of Shida at the Institute of Technology at Tokyo, the work of Imamura on linear energy transfer in methanol radiolysis, spin resonance studies of irradiated organic glasses of Kuri, and liquid-state polymerization studies of Okamura, Hayashi, and their collaborators are particularly noted. Studies of pressure on solid-state polymerization of acrylamide, methacrylonitrile, diketene, and trioxane are explained. (BBB)

4190 STEREOREGULARITY AND REACTION OF POLYACRYLATES AND POLYACRYLONITRILES. Matsuzaki, Kei; tokyo Univ.); Uryu, Toshiyuki; Ishida, Akira; Takeuchi, Makoto. J. Polym. Sci., Part C, No. 16, 2099-2110(1967).

From IUPAC Meeting on Macromolecular Chemistry, Prague, Aug. 30–Sept. 4, 1965. See CONF-650801-(Pt.4).

Reactions of polyacrylates of different stereoregularities are briefly outlined. NMR spectra of poly(methyl acrylates) polymerized with various initiators and also those of model compounds were analyzed and compared. Theoretical spectra agreed well with the observed ones. In order to examine the stability of tertiary CH polyacrylonitrile and polyacrylonitrile-α-d were hydrolyzed with sodium hydroxide solution, sulfuric acid, or deuterated sulfuric acid, and racemization of the tertiary carbons was found. (auth)

4191 STEREOREGULARITY OF POLY(METHACRYLIC ACID ESTERS). Matsuzaki, Kei; Ishida, Akira; Tateno, Noriaki (Tokyo Univ.). J. Polym. Sci., Part C, No. 16, 2111-20(1967).

From IUPAC Meeting on Macromolecular Chemistry, Prague, Aug. 30–Sept. 4, 1965. See CONF-650801-(Pt.4).

l-Menthyl methacrylate (l-MnMA) and dl-MnMA and their mixtures were polymerized with benzoyl peroxide (BPO), phenylmagnesium bromide (PhMgBr), and lithium aluminum hydride ($LiAlH_4$), as catalyst. The isotacticity of the polymers of dl-MnMA polymerized with PhMgBr was independent of the polymerization temperature and low. The tacticity of the polymers from the mixtures of l- and dl-MnMA's polymerized with BPO hardly changed with monomer compositions, while that with $LiAlH_4$ showed increase with the increase of l-monomer contents. The change of the optical activity of PMnMA's with the stereoregularity was slight as compared with large variation of the tacticity of the polymers. Although both in radical and anionic polymerizations preference of one monomer to another monomer does not occur, in isotactic polymerization with $LiAlH_4$ asymmetric induction of menthyl groups on the main chain configurations takes place. The tacticities of some poly(methacrylic acid esters) polymerized with PhMgBr under similar conditions were compared. (auth)

4192 EFFECTS OF GAMMA RAYS ON POLY-2- AND -4-VINYLPYRIDINES. David, C.; Verhasselt, A.; Geuskens, G. (Univ. Libre, Brussels). J. Polym. Sci., Part C, No. 16, 2181-9(1967). (In French).

From IUPAC Meeting on Macromolecular Chemistry, Prague, Aug. 30–Sept. 4, 1965. See CONF-650801-(Pt.4).

γ-Irradiated poly-2-vinylpyridine (2-PVP) and poly-4-vinylpyridine (4-PVP) become crosslinked and partially insoluble. The G value for crosslinking was determined for atactic (0.27) and isotactic (0.65) 2-PVP and for atactic 4-PVP (0.33). The results were compared with published data on polystyrene. ESR spectra of irradiated 2-PVP and 4-PVP suggest that a cyclohexadienyl type radical is formed, as in polystyrene. A chain reaction involving direct intramolecular hydrogen transfer is proposed to explain the experimental results. (auth)

4193 RADIATION-CHEMICAL PREPARATION OF POLYSULFONE AT VARIOUS TEMPERATURES. Schneider, Christel; Denaxas, Jannis; Hummel, Dieter (Univ., Cologne). J. Polym. Sci., Part C, No. 16, 2203-13(1967). (In German).

From IUPAC Meeting on Macromolecular Chemistry, Prague, Aug. 30–Sept. 4, 1965. See CONF-650801-(Pt.4).

Under the influence of ^{60}Co γ rays copolymers of vinyl chloride and SO_2 were prepared at various temperatures between +20 and −75°C; the molar ratio of vinyl chloride and SO_2 in the polysulfone formed at +20°C is about 2. With decreasing temperatures the sulfur content of the polysulfone increases, and at −75°C the molar ratio VC/SO_2 in the copolymer averages about 1.4. For all temperatures used the composition of the polysulfone is independent of the composition of the reaction mixture. However, the polymerization rate is dependent on vinyl chloride concentration in the feed. The temperature coefficient of the polymerization rate is negative for vinyl chloride concentrations up to 50 mole % in the reaction mixture. The reaction mechanism, according to the reaction temperature, is presumed to be a radical copolymerization between the vinyl chloride monomer and a 1:1 vinyl chloride/SO_2 complex, or between two vinyl chloride/SO_2 complexes. Furthermore, the copolymerization of 2-vinylpyridine, 4-vinylpyridine, and 4-vinylcyclohexene with SO_2 was investigated. No polysulfone was formed in the case of the vinylpyridines, neither at room temperature nor

at low temperatures. 4-Vinylcyclohexene, on the other hand, formed a polysulfone. (auth)

4194 INVESTIGATION OF POLYMERIZATION AT HIGH PRESSURES. Zharov, A. A.; Berlin, Al. Al.; Enikolopyan, N. S. (Inst. of Chemical Physics, Moscow). J. Polym. Sci., Part C, No. 16, 2313-22(1967).

From IUPAC Meeting on Macromolecular Chemistry, Prague, Aug. 30–Sept. 4, 1965. See CONF-650801-(Pt.4).

The polymerization kinetics of three types was investigated under high pressure: radical propylene polymerization, cationic styrene polymerization, and trioxane polymerization in the solid state. Two first reactions are accelerated by pressure and the rate of solid-state polymerization of trioxane is decreased by pressure. A kinetic scheme accounting for the experimental results is suggested. (auth)

4195 SOME ASPECTS OF THE POLYMERIZATION IN THE SOLID STATE. Berlin, Al. Al.; Trofimova, G. M.; Pakhomova, L. K.; Prut, E. V.; Barkalov, Ya. M.; Kuzmina, S. M.; Enikolopyan, N. S.; Goldanskii, V. I. (Inst. of Chemical Physics, Moscow). J. Polym. Sci., Part C, No. 16, 2323-32(1967).

From IUPAC Meeting on Macromolecular Chemistry, Prague, Aug. 30–Sept. 4, 1965. See CONF-650801-(Pt.4).

The formal kinetics of the solid-state polymerization allowing for the specificity of the solid state as such (the long times of diffusion, anisotropy, and inhomogeneity of the solid phase) were considered. All possible changes in inhomogeneity of the system in the course of polymerization were taken into consideration. The applicability of this kinetic scheme was shown for radioinduced post-polymerization and cationic polymerization of trioxane in the solid state. The occurrence of chain transfer to polydioxalane in cationic solid-state polymerization of trioxane was proved. (auth)

4196 SOLID- AND LIQUID-STATES POLYMERIZATION OF TETRAFLUOROETHYLENE INDUCED BY IONIZING RADIATION. Tabata, Yoneho (Tokyo Univ.); Shibano, Hiroshi; Oshima, Keichi; Sobue, Hiroshi. J. Polym. Sci., Part C, No. 16, 2403-16(1967).

From IUPAC Meeting on Macromolecular Chemistry, Prague, Aug. 30–Sept. 4, 1965. See CONF-650801-(Pt.4).

Solid-state polymerization of tetrafluoroethylene was carried out by initiation with γ rays from ^{60}Co and electrons from a Van de Graaff generator. Apparent activation energy of the polymerization in the solid state was about 0.3 kcal/mole. The polytetrafluoroethylene, which was obtained both in liquid- and solid-state polymerizations, was examined by the infrared and x-ray diffraction methods. From these experiments it was clearly demonstrated that the crystalline structure is quite different between both polymers. It indicates that the polymerization in the solid state is strongly influenced by the crystal lattice of the monomers. (auth)

4197 RADIATION-INDUCED POLYMERIZATION OF STYRENE OXIDE. Tabata, Yoneho (Tokyo Univ.). J. Macromol. Sci., Pt. A, A1: 493-502(1967).

Radiation-induced polymerization of styrene oxide in the liquid and solid states was carried out by initiation with γ rays from ^{60}Co and electrons from a Van de Graaff accelerator. Effects of dose rate, a radical inhibitor, and temperature on the polymerization were examined. Infrared spectra and viscosities of polymers obtained were measured. The results showed that apparent activation energies were 6.2 kcal/mole for the liquid-state polymerization and 0.17 kcal/mole for the solid-state polymerization. Polymerization in liquid state was inhibited and retarded by p-benzoquinone. The rate of polymerization was proportional to the dose rate, and viscosity of the polymers obtained increased with irradiation dose. The ir spectrum of polymers obtained varied with the polymerization temperature. It is pointed out that chain-transfer and isomerization reactions are rapid and play an important role in the polymerization of styrene oxide, and that the polymer-forming process is not as rapid, owing to a step-by-step type of growth. (BBB)

4198 SOLVATED ELECTRON SPECTRUM IN IRRADIATED ICE. Eiben, K.; Taub, I. A. (Mellon Inst., Pittsburgh). Contract AT(30-1)-2310. Nature (London), 216: 782-3(Nov. 25, 1967).

In recent pulse radiolysis studies on transparent samples of ice it was found that for e^- the optical absorption maximum (λ_{max}) shifts to shorter wavelengths as the temperature is decreased; the yield also decreases and the lifetime increases. Observations indicated that an ice sample, highly irradiated with ^{60}Co gamma rays at 77°K, might show a stable, low yield e_s^- having an absorption maximum at about 6300 Å. Experiments are described to test this hypothesis. A maximum was found at 6400 ± 100 Å, and the yield of this absorption increased with dose up to about 5MR, then approached a plateau value. A G-value of 2×10^{-4} was estimated. Although the absorption appeared to be thermally stable at 77°K, it could be photo-bleached with visible light. The absorption disappeared on warming to 112°K. The fact that a stable solvated electron absorbing below 7000 Å can be formed in ice has relevance for theories relating to the formation, structure, and decay of this entity in other media, such as liquid water and alkaline ice glasses. (UK)

4199 RADIATION DAMAGE STUDY OF CRYSTALLINE ANTHRACENE. Heppell, G. E.; Hardwick, R. (Univ. of Calif., Los Angeles). Trans. Faraday Soc., 63: 2651-5(Nov. 1967).

Damage to thin anthracene crystals by moderate α bombardment may be arbitrarily classified into physical and chemical categories. Annealing damaged crystals restores only part of the physical damage; dissolving an irradiated crystal, with the resulting loss of the damaged lattice, reveals more. The chemical damage, however, remains even after solution of the crystal. Assessments of damage were made by scintillation efficiency decline. (auth) (UK)

4200 RADIOLYSIS OF AQUEOUS SOLUTIONS OF NITRIC OXIDE. Knight, R. J.; Sutton, H. C. (Univ. of Edinburgh). Trans. Faraday Soc., 63: 2628-39(Nov. 1967).

Earlier studies were extended over a range of pH and of NO concentration. The modified simple mechanism suggested for alcohol + NO solutions accounts quantitatively for all the data at pH 7. Nitrogen yields from irradiated NO + N_2O mixtures conform with a simple competition for e_{aq}^- without intervention of the long-lived species N_2O^- previously suggested. Thermal reactions of H_2O_2 in acid and alkaline solutions are considered and kinetic data are reported. ($G_{e_{aq}^-} + G_H$) measured as $G(N_2O)$ for 1.9 mM NO increased from 3.15 ± 0.1 at pH 7 to 3.6 ± 0.1 at pH 0.45 and to 3.40 ± 0.15 at pH 12.8. $G_{OH} + G_{e_{aq}^-} + G_H$ measured as $G(NO_2^-)$ at pH 7 increased linearly with $[NO]^{\frac{1}{2}}$ from 5.65 ± 0.15 in 0.5 mM NO to 6.80 ± 0.25 in 13 mM NO. No evidence was found for the formation of O atoms. The data are discussed in relation to current theories. (auth) (UK)

4201 STUDIES OF RADIATION-INDUCED REACTIONS OF ETHYLENE IN AQUEOUS SOLUTION. II. REACTIONS IN THE PRESENCE OF OXYGEN AS STUDIED BY PULSE RADIOLYSIS AND γ-IRRADIATION TECHNIQUES. Cullis, C. F. (Imperial Coll. of Science and Tech., London); Francis, J. M.; Raef, Y.; Swallow, A. J. Proc. Roy. Soc. (London), Ser. A, 300: 443-54 (Sept. 26, 1967).

The radiolysis of dilute aqueous solutions containing ethylene and oxygen was investigated. Pulse radiolysis was used to measure the rate constants for addition of hydroxyl radicals to ethylene, the binary decomposition of the resulting hydroxyethyl radicals and their addition to ethylene and reaction with oxygen to yield peroxy radicals. The rate constants were also determined for the mutual interaction of the peroxy radicals and their reaction with ferrous ions. The principal products of γ-irradiation were aldehydes and organic hydroperoxides. Hydrogen peroxide was found in yields close to the molecular yield from water. The polymer produced in the absence of oxygen was not formed, and glycollaldehyde, reported as a major product by previous workers, could not be detected. At constant composition of the gas mixtures, product yields were unaffected by total pressure in the range up to 40 atm, but were strongly dependent on the proportion of oxygen. Aldehyde yields were markedly greater at pH 1.2 than in neutral solution. The influence of ferrous ions and of added hydrogen peroxide was determined. The pulse radiolysis and γ-irradiation experiments complement one another and show that the radio-induced oxidation of ethylene in aqueous solution involves the same primary reactions as occur in the absence of oxygen, followed by the formation and further reactions of peroxy radicals. (auth) (UK)

4202 RADIOLYSIS OF LIQUID MERCURY DI-N-HEXYL. Barker, R. (Atomic Energy Research Establishment, Wantage, Eng.). Trans. Faraday Soc., 63: 2640-50(Nov. 1967).

The radiolysis of liquid mercury di-n-hexyl gave mercury, hexane, hexene, and dodecane as the principal products, indicating that only mercury–carbon bond cleavage takes place. The ratio of disproportionation to combination of n-hexyl radicals in this environment was 0.73. A study of the effect of varying the dose-rate on the system indicated that the chain reaction $C_6H_{13}\cdot + Hg(C_6H_{13}\cdot)_2 \rightarrow C_6H_{14} + C_6H_{12} + Hg + C_6H_{13}$ takes place. The rate constant for this reaction was estimated as 38 l mole^{-1} sec^{-1} and was low because of a low pre-exponential factor. (auth) (UK)

4203 ATOMIC ^{35}S IN AN ALKALI CHLORIDE MATRIX. Freeman, J. H. (Atomic Energy Research Establishment, Harwell, Eng.); Kasrai, M.; Maddock, A. G. Chem. Commun., No. 19, 979(1967).

It was found that the ^{35}S produced in neutron-irradiated crystalline alkali chloride is present in four distinguishable forms. These These comprise sulphide ions, atomic sulphur, and two kinds of S-Cl complexes, formed by interaction of the sulphur with V-centers and their derivatives. The formation of these four species was also observed when ^{35}S was introduced into NaCl crystals by ion implantation using a 40-keV $^{35}S^+$ beam. The greater part of the

sulphur introduced by the latter process penetrates <5μ, but the presence of air or oxygen has no appreciable effect on the ^{35}S distribution. Differences in concentration and distribution of defects leads to differences in annealing behavior of the ^{35}S, and such differences may facilitate identification of mechanisms. (UK)

4204 EFFECT OF AN APPLIED ELECTRICAL FIELD ON THE GAMMA RADIOLYSIS OF GASEOUS HYDROGEN CHLORIDE. Lee, R. A. (Puerto Rico Nuclear Center, Mayaguez). Nature (London), 216: 57-8(Oct. 7, 1967).

Studies on the gamma radiolysis of HCl gas provided evidence for the presence of two hydrogen-forming species, the first being a "hot" hydrogen atom, possibly formed by the excitation process $HCl \rightsquigarrow HCl^* \rightarrow H^* + Cl$, and the second a "thermal" H-atom, which may or may not have a thermalized electron as its precursor. The initial ionizing action should produce both excited HCl molecules and HCl^+ ions, together with electrons: $HCl \rightsquigarrow HCl^+ + e$. With a view to interpreting the subsequent reactions of the ions produced by the latter reaction a study was made of the effect of an applied electric field during radiolysis. Experimental details are described. Gas pressures ranged from 150 to 700 torr, and a field gradient from 0 to 6 V/cm/torr was applied. The samples were irradiated with a 1,200-Ci ^{60}Co source. Plots are shown of ion pair yield of hydrogen production against applied field, and ionization current against applied field. It was found that the electric field had no effect on the production of hydrogen either in the ion recombination region or in the saturation region, this being interpreted as meaning that ion recombination reactions do not play an important part in the hydrogen formation. The possible reactions of the electrons produced are considered. These electrons should become thermalized and may disappear by any of the following processes: ambipolar to the vessel walls; ion-electron recombination; or attachment to neutral molecules to form negative ions. Evidence was obtained that the electrons disappear in a trimolecular reaction, thus:

$$e + HCl + HCl \rightarrow \text{electron–HCl complex} \downarrow H + Cl^-_{(HCl)}$$

The HCl^+ ion can undergo charge neutralization by reacting either with an electron or the Cl^- ion, or else can take part in the ion-molecule reaction $HCl + HCl^+ \rightarrow H_2Cl^+ + Cl$, but its fate is chiefly to form H_2Cl^+. This latter ion would be the cation collected on application of an electric field. Clustering of the H_2Cl^+ and Cl^- ions would be expected to occur, followed by a non-dissociative recombination of the clustered ions. There is no change in the ionic yield in the ion recombination region during application of an electric field. (UK)

4205 INVESTIGATION OF ISOMERIZATION PROCESS OVER RADIOACTIVE MAGNESIUM SULFATE. Mikhailenko, I. E.; Petrova, O. M. (Inst. of Physical Chemistry, Moscow). Isotopenpraxis, 3: 361-3(Sept. 1967). (In Russian).

Isomerization processes of hexene-1 and decene-1 during dehydration of aliphatic alcohols over radioactive $MgSO_4$ were studied. With the help of ^{35}S in $MgSO_4$, the question about isomerization mechanism of the olefin in its formation as a result of alcohol dehydration was decided. For the first time isomerization of decene-1 over highly radioactive $MgSO_4$ was carried out; this did not take place over $MgSO_4$ without the radioactive isotope. (auth)

4206 THE EFFECT OF ^{60}Co γ RADIATION ON THE KINETICS OF THE REACTIONS BETWEEN MEALS AND IODINE VAPOR. Sugier, Henryk (Lodz Polytechnic Inst., Poland). Nukleonika, 12: 891-7(1967). (In Polish).

The effects of ^{60}Co γ radiation on the rate of the reaction between eight metals and iodine vapor at room temperature were investigated. It was found that radiation increases the rate of iodination of antimony, copper, and silver, and decreases that of tin, cadmium, mercury, and lead. In the case of bismuth the reaction was at first inhibited, but then enhanced. A relation was found between the effect of ^{60}Co γ radiation on the iodination reaction and the direction and character of the diffusion in the growing layer of the reaction product. (auth)

4207 PRODUCTION OF RADIOACTIVE SOURCES OF ALKALI-METAL AND ALKALINE-EARTH ISOTOPES. Bilaniuk, O. M. (Swarthmore Coll., Pa.); Shafroth, S. M. Nucl. Instrum. Methods, 57: 177-8(Dec. 1967).

A method for producing sources of alkali metal and alkaline earth isotopes by alpha bombardment of rare gases in a cell lined with removable mylar film is described. Gamma rays arising from the decay of ^{83}Rb and ^{85}Sr sources adsorbed on the mylar film were observed with a 17 cm^3 Ge(Li) detector. (auth)

4208 EFFECT OF γ RADIATION ON THE THERMAL CONDUCTIVITY OF POLYPROPYLENE. Tomlinson, J. N.; Kline, D. E. (Pennsylvania State Univ., University Park). J. Appl. Polymer Sci., 11: 1931-40(Oct. 1967).

The effect of ^{60}Co γ radiation on the thermal conductivity of polypropylene (PP) was studied over the temperature range from 0 to 160°C for radiation doses of 600 and 1800 MRAD. The conductivity of unirradiated specimens increased from 4.5×10^{-4} cgs units (cal./cm.-sec.-°C) at 0°C to 4.8×10^{-4} cgs units at 80°C and subsequently decreased with temperature to a value of about 3.1×10^{-4} cgs units at 160°C. On irradiation to 600 MRAD the thermal conductivity was lowered over the 0 to 150°C temperature range. Above 90°C the conductivity decreased with temperature and became relatively constant at 3.4×10^{-4} cgs units from 120 to 160°C. Differential scanning calorimeter (DSC) measurements from 30 to 200°C showed that irradiation to 600 MRAD lowers the energy associated with crystalline melting and shifts the endotherm melting peak from about 160 to 105°C. Irradiation to 1800 MRAD resulted in additional lowering of the thermal conductivity over the 50 to 160°C range, a further decrease in area of the endothermic peak, and a shift of its maximum peak position to about 75°C. The effects of radiation on the thermal conductivity of polypropylene were compared and correlated with the observed effects of radiation on the dynamic mechanical behavior. (auth)

4209 CAPTURED ELECTRON IN POLAR SYSTEM RADIOCHEMISTRY. Ershov, B. G.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). Zh. Fiz. Khim., 41: 2573-85(Oct. 1967). (In Russian).

The formation of electrons during ionizing irradiation of various polar systems and electron stabilization at certain conditions at low temperatures were investigated. Summarized results are given on the investigation of the nature and properties of electrons captured in congealed water and alcohol solutions. Optical spectra of electrons captured in aqueous matrices at 77°K and yields of captured and thermalized electrons during γ irradiation of aqueous glass at 77°K are given as well as the optical spectra of electrons captured in alcohols and water–alcohol mixtures (methanol, ethanol, isopropanol, butanol, ethylene glycol, glycerol, and mixtures of methanol, ethylene glycol, and glycerol with water. (R.V.J.)

4210 FORMS OF STABILIZED ^{113m}Sn RECOIL ATOMS IN REACTOR-IRRADIATED TIN OXIDES. Nesmenanov, An. N.; Babeshkin, A. M.; Pokholok, K. V.; Bekker, A. A. Radiokhimiya, 9: 392-4(1967). (In Russian).

Tix oxide was exposed to reactor irradiation and the recoil atom ^{113m}Sn was determined in the oxide, dioxide, and metallic form by radiochemical analysis in order to determine the stabilization of the recoil atom is in the form of the dioxide, which explains its high thermal stability. The reduction in the amount left in the original material in the case of the irradiation of tin oxide can explain its lower thermal stability. (J.S.R.)

4211 I KRAJOWE SYMPOZJUM CHEMII JADROWEJ, 10–12 LUTY 1964, WARSZAWA. (First National Symposium on Nuclear Chemistry, Feb. 10–12, 1964, Warsaw). Nukleonika, 10: Suppl., 1-464(1965). (CONF-640210).

The proceedings of the First National Symposium on Nuclear Chemistry held in Warsaw, Poland, are published in Polish with English summaries for the individual papers. The entire proceedings are divided into 4 sections. Separate abstracts were prepared for 37 papers. (B.L.M.)

For abstracts of individual papers see: 4049–4055, 4129–4138, 4212–4219, 4255–4260, 4275, 4421, 4468, 4494, 4626, and 4807.

4212 CHEMICAL AND RADIOCHEMICAL CONTROL OF RADIOISOTOPIC PREPARATIONS. Pasternak, A. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 321-4 (1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Criteria for the choice of methods for chemical and radiochemical control of radioisotope preparations are characterized. The methods, especially those used for control of radioisotope preparations for medical uses, are briefly described. (auth)

4213 RESEARCH WORK ON RADIATION CHEMISTRY OF POLYMERS AT THE DEPARTMENT OF CHEMICAL TECHNOLOGY OF WARSAW UNIVERSITY. Orszagh, A.; Zurakowska-Orszagh, J. (Univ. of Warsaw). Nukleonika, 10: Suppl., 389-93 (1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

The following problems, being studied at the Department of Chemical Technology of Warsaw University, are discussed: kinetics and mechanism of solid-state polymerization for a series of crystalline monomers in connection with the structure of monomer molecules and structural parameters of crystals; influence of the presence of a heavy metal heteroatom in the molecule on

the behavior of olefins under irradiation and dependence of solid-state radiation copolymerization on the phase equilibria of the binary monomer systems and the crystal structure. Effects of irradiation on the physical and chemical properties of a range of polymers, especially the permeability of foils to gases and vapors, changes in mechanical properties of fibers, and resistance of coatings of different composition were studied. Radiation crosslinking of ethylene–propylene copolymers of different composition was investigated as well as effects of radiation on grafted copolymers of natural rubber. Radioinduced grafting of cellulose and polyamide foil and fibers as well as polyacrylonitrile fibers by simultaneous as well as preirradiation methods was also investigated. (auth)

4214 INVESTIGATIONS ON THE RADIATION INDUCED MODIFICATION OF ELASTOMERS. Achmatowicz, T.; Smigasiewicz, Z.; Zielinski, W. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 395-408(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

The influence of ionizing radiation on the vulcanization of natural rubber, latex, and sulfur vulcanates of butyl rubber, as well as the role played by solid additives (oxides and halides of metals and organic sensitizers) was investigated. Natural rubber with inorganic additives undergoes crosslinking under γ radiation, and the rate of crosslinking increases with the atomic number of the metal with the exception of CuO and PbO. Chloroform was studied as an organic sensitizer, and this compound greatly accelerates the crosslinking process. Polyisobutylene and the vulcanates of butyl rubber undergo deep degradation under γ radiation; however, the degradation products have valuable properties and may be used for production of sealing compositions. Radiation methods for reclamation of old motor tires and old butyl tubes were developed. (auth)

4215 THE INVESTIGATION OF RADIOLYSIS OF AQUEOUS SOLUTIONS WITH PARTICULAR CONSIDERATION OF Fe(II)–Fe(III) SYSTEM. Minc, S.; Broszkiewicz, R.; Stolarczyk, L.; Wezranowski, E.; Zagorski, Z. P. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 413-21(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Results of research on oxidation of ferrous and reduction of ferric ions in aqueous solution are discussed. From the experimental and theoretical results a better knowledge of phenomena occurring in solutions with organics present was gained and the expected reaction mechanisms were confirmed. Results of investigations on neutral solution are discussed. The results obtained, as a whole, seem to have both chemical and biological significance. (auth)

4216 MAIN RESEARCH PROBLEMS IN THE INSTITUTE OF RADIATION CHEMISTRY AT THE TECHNICAL UNIVERSITY OF LODZ. Kroh, J. (Technical Univ., Lodz, Poland). Nukleonika, 10: Suppl., 423-32(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Basic research work in the Institute of Radiation Chemistry in Lodz is being developed in three main directions: fundamental research in radiation chemistry (energy transfer in solid systems, radioinduced isotopic exchange, radiolysis of ice and water); radiation chemistry of polymers (polymerization and degradation in solution and in solid phases); and research carried out in collaboration with the Faculty of Food Chemistry (e.g. microbiological effects, the influence of ionizing radiation on vitamins etc.). (auth)

4217 RADIATION CHEMISTRY OF ALKALINE SOLUTIONS OF OXYANIONS OF TRANSITION ELEMENTS. Jezowska-Trzebiatowska, B.; Kalecinski, J. Nukleonika, 10: Suppl., 433-40(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

The reduction of oxyanions of Mn and Cr in alkaline solutions was investigated. $G(-MnO_4^{2-}) = 1.8$ equivalents/100 eV for all Mn oxyanions. The γ-irradiated CrO_4^{2-} ions were reduced only in solutions saturated with hydrogen. $G(-CrO_4^{2-})$ decreased with increases in concentration of CrO_4^{2-} accumulated with time of irradiation. Mechanisms of reduction of Mn and Cr oxyanions irradiated by γ rays are supplied. The yields from radiolysis of alkaline solutions were calculated: $G_H = 3.79$; $G_{OH} = 3.0$; $G_{H_2O_2} = 0.51$; $G_{H_2} = 0.12$. (auth)

4218 INVESTIGATIONS ON RADIATION CHEMISTRY CARRIED ON IN THE INSTITUTE OF GENERAL CHEMISTRY AND OTHER RESEARCH INSTITUTES OF MINISTRY OF CHEMICAL INDUSTRY. Ciborowski, St. (Inst. of General Chemistry, Warsaw). Nukleonika, 10: Suppl., 441-6(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

The main trends of investigations carried on are connected with processes in which small amounts of radiation energy are involved (e.g. chain reactions and radiolysis of impurities in chemical products), processes in which expensive products are formed, and with problems of radiation influence on solid catalysts. (auth)

4219 APPLICATION OF MASS SPECTROMETRY TO THE STUDY OF PRIMARY RADIATION PROCESSES OF ORGANIC SUBSTANCES. Kecki, Z.; Wincel, H.; Stachowicz, W.; Minc, S. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 447-58(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

On the basis of numerous experiments performed with the mass spectrometer, probabilities of formation of excited and ionized tetrahydronaphthalene molecules under electron impact were calculated. The schemes for fragmentation of ionized molecules and distribution of unimolecular decomposition products for a liquid phase were established. Based on energy considerations, conclusions about the structure of fundamental ions in the primary process were postulated. The series of secondary processes, such as ion-molecule and radical and atom reactions, were considered. Conclusions were drawn about the mechanism of tetrahydronaphthalene radiolysis in a liquid phase. A correlation between results obtained in this way and the yields of final products given from a study of γ-radiolysis of tetrahydronaphthalene in a liquid phase was obtained. (auth)

4220 ELECTRON SPIN RESONANCE SPECTRA OF γ-RAY IRRADIATED GERMANATE, PHOSPHATE, AND ARSENATE GLASSES. Weeks, Robert Andrew. Providence, Brown Univ., 1966. 101p.

Thesis.

Alkali-germanate glasses with molar ratios of GeO_2/Na_2 in the range from 333 to 3.33 were irradiated with ^{137}Cs γ rays to a dose of $\sim 3 \times 10^8$ R at a temperature of ~35°C. Electron spin resonance (ESR) measurements at ~10 Gcps were made at ~300 and 78°K. At ~300°K the spectra was composed of two well resolved asymmetric resonances whose shapes corresponded to the shape expected for the powder-line shapes of paramagnetic centers with axially symmetric g-tensors and with a spin state $S = \frac{1}{2}$. Assuming that the resonances are due to centers with axial symmetry, the principal values of the g-tensor for one center are $g_{||} = 2.0016 \pm 0.0006$ and $g_{\perp} = 1.9960 \pm 0.006$, and for the second center $g_{||} = 2.003 \pm 0.001$ and $g_{\perp} = 2.090 \pm 0.001$. For constant irradiation conditions the concentration of centers with the smaller g-values decreased with decreasing molar ratio, while the concentration of centers with the larger g-values increased initially with decreasing molar ratio. For a molar ratio of 3.33 neither resonance was detected. The observed g-values are compared with those calculated for a non-bridging oxygen vacancy and a bridging oxygen vacancy, and the observed changes in intensity of centers are explained on this basis. Polycrystalline P_2O_5, glassy P_2O_5, alkali-phosphate glasses, alkaline earth-phosphate glasses, and alkali-alkaline earth-phosphate glasses were irradiated under the same conditions. ESR measurements were made at ~10 and 35 Gcps on three of the glasses. The ESR spectra of the polycrystalline and glassy P_2O_5 were identical within the accuracy of the measurement. The spectra observed in each of the glasses is described by spin Hamiltonians $\mathcal{H} = \beta \vec{H} \cdot \vec{g} \cdot \vec{S} + \vec{I} \cdot \vec{A} \cdot \vec{S}$ with $S = \frac{1}{2}$ and $I = \frac{1}{2}$. The nucleus was ^{31}P. In glasses three independent Hamiltonians of this form were required to describe the spectra. With one exception, the shapes of the components of each hyperfine doublet were in approximate agreement with the powder-line shapes for a doublet with an approximately isotropic g-tensor, a large isotropic, and a small anisotropic hyperfine interaction. The isotropic part of the hyperfine interaction was found to vary from glass to glass, being larger for pure P_2O_5 and for those glasses for which the molar ratio of $P_2O_5/Na_2O > 1$. The isotropic hyperfine interaction ranged from 1890 to 4490 Mcps. The anisotropic hyperfine interaction was approximately the same for all the glasses and was estimated to be ~280 Mcps. Neglecting the anisotropic hyperfine interaction, an approximate isotropic hyperfine interaction constant and an average g-value are calculated using the Breit-Rabi equation. This average g-value (2.01) and the value of $g_{\perp}$ (2.006) calculated for a non-bridging oxygen vacancy in P_2O_5 are in approximate agreement. It is suggested that the variation in the isotropic hyperfine interaction from glass to glass is due to a variation in the sp hybridization of the defect orbital state. Alkali-arsenate glasses with molar ratios of As_2O_5/Na_2O, ranging from 333 to 3.33, were irradiated under the same conditions as a dose of $\sim 3 \times 10^8$ roentgens at ~35°C. ESR measurements were made at ~10 Gcps. No resonances were detected which could be attributed to the irradiation. (Disser. Abstr.)

4221 PROCESS FOR PREPARING SULPHONIC ACIDS. (to Farbwerke Hoechst AG). British Patent 1,089,808. Nov. 8, 1967. Priority date May 4, 1965, Germany.

In a process for the preparation of sulfonic acids, a gaseous mixture containing SO_2 and O_2 is subjected to gamma, x, beta, or electron radiation and then is subsequently used to sulfonate a saturated cycloaliphatic or aliphatic hydrocarbon containing 10 to 30 C atoms/molecule or a mixture of two or more such hydrocarbons. In the gaseous mixture the molar ratio of SO_2 to O_2 is greater than 2:1, and the volume ratio of hydrocarbon or hydrocarbons present in the sulfonation zone lies in the range of 10:1 to 1000:1. The sulfonic acids may be prepared at temperatures within the range from −20 to 100°C, preferably 0° to 30°C. (B.L.M.)

4222 THE EFFECTS OF PRE-IRRADIATION ANNEALING ON THE THERMOLUMINESCENCE, DIELECTRIC LOSS, AND OPTICAL ABSORPTION OF LiF:Mg. Grant, Roderick McLellan Jr. Madison, Wis., Univ. of Wisconsin, 1965. 101p.

Thesis.

The character of radioinduced thermoluminescent glow peaks in LiF:Mg (70 and 100 ppM by spectrographic analysis) are affected by pre-irradiation isothermal annealing. The effects were studied at annealing temperatures between 25 and 150°C. At temperatures below 100°C the pre-irradiation annealing kinetics of one of the glow peaks that appears in both samples at about 105°C was correlated with the annealing kinetics of quenched-in Mg^{2+} cation vacancy complexes as measured by dielectric loss techniques. After the sample was annealed for one hour at 400°C and cooled in about 3 min to room temperature, almost all of the Mg was found to be associated with cation vacancies in the 70 and 100 ppM sample. The total glow curve area is greater by a factor of 30 in the 100 ppM sample as compared to the glow curve from the 70 ppM sample, but the 105°C glow peak associated with the Mg^{2+} cation vacancy complex is proportional to the measured number of these complexes in the two samples. An optical absorption band appearing at 380 mu after irradiation to about 10^5 was also correlated with the 105°C glow peak. Changes in the optical absorption spectrum occurred as a result of pre-irradiation annealing and also as a result of pulse annealing after irradiation to remove the 105°C glow peak. These suggest a complex interaction between several color centers. A band at 310 mu is enhanced by either pre-irradiation annealing or by pulse annealing after irradiation. A band at 220 mu grows as a result of the pulse annealing procedure, but it is apparently not affected by the pre-irradiation annealing. The F band at 250 mu decreases as a result of the pulse annealing procedure, but it is apparently not affected by pre-irradiation annealing. The F band at 250 mu is reduced by the pulse annealing procedure, but optical bleaching of the 380 mu band does not affect the F band. The 105°C glow peak decays at room temperature to 50% of its initial value in 10 hr, after which time the decay proceeds at a slower rate, which is dependent on the concentration of impurity. One component of the 380 mu absorption band also decays with a half life of about 10 hr, but this component only represents about 20% of the total band. The second component of the absorption band decays more slowly, with about 25% of the original band still present after two weeks. This behavior, together with other considerations, suggests that only a fraction of the filled Mg^{2+} cation vacancy traps participate in thermoluminescence; i.e., the efficiency of the trap in terms of photons emitted per color center is apparently low. It is suggested that temperature-dependent chemical reactions may occur in the crystal, which (a) break up the color center and produce a new color center without the release of an electron, and/or (b) combine two different color centers to form a third color center without the release of trapped electrons from either original center. The efficiency of the thermoluminescence of the glow peak being studied appeared to depend on the availability of recombination centers, which suggests the possibility that thermoluminescence depends on the proximity of these centers, and hence may indicate a tunneling process for the recombination mechanism. (Disser. Abstr.)

4223 GAMMA-RADIATION INDUCED POLYMERIZATION OF STYRENE: NOVEL KINETICS FOR THE PURE, LIQUID MONOMER. Potter, Richard Curtiss. New Haven, Yale Univ., 1967. 214p.

Thesis.

Kinetic studies were made of the ^{60}Co γ-initiated polymerization of exhaustively dried and purified styrene, over a temperature range from 0 to 50°C and a dose rate range from to 10^6 RAD/hr. Relying principally on dilatometric techniques, it was found that this system exhibits kinetic behavior that is in complete disagreement with the previously accepted free-radical mechanism for the pure, liquid monomer. This departure from classical behavior is characterized by: extreme sensitivity to impurities, particularly water; very high reaction rates (e.g., 940%/hr at 0°C and a dose rate of 1 MRAD/hr); molecular weights that are independent of dose rate and that vary inversely with temperature; temperature coefficients of low magnitude; and a linear dependence of polymerization rate on dose rate which, for even more rigorously pure conditions, decreases to a value of 0.7. On the basis of these results, the polymerization is believed to proceed by ionic propagating species. It is suggested that these species are carbonium ions, and that carbanions may also be stabilized under sufficiently anhydrous conditions. Termination is shown to occur primarily by chain transfer, although the presence of carbanions would introduce the possibility of bimolecular termination by oppositely charged polymeric ions. No surface effect was found in the system. Also, conventional initiation of ultra-pure styrene, either by heat or by uv radiation, did not produce any of these novel effects. Ultra-pure methyl methacrylate was prepared, but exhibited the normal free radical behavior for radiation polymerization. (Disser. Abstr.)

4224 THE ISOTOPE INDEX. TENTH ANNIVERSARY EDITION. COMPLETE GUIDE TO THE ISOTOPES. VOLUME VIII. Sommerville, J. L. (ed.). Indianapolis, Scientific Equipment Co., 1967. 360p. $12.00 (Hardbound); $10.00 (Paperback).

Labeled compounds available, suppliers, and costs are listed for various radioisotopes. (M.C.G.)

4225 I. INFRARED SPECTRA OF MONOMERIC AND POLYMERIC HCl AND DCl IN SOLID KRYPTON AND XENON. II. INFRARED SPECTRA OF NH_2 AND ND_2 PRODUCED BY PHOTOLYSIS AND X-RADIOLYSIS OF AMMONIA IN SOLID KRYPTON. III. ULTRAVIOLET SPECTRA OF CH PRODUCED BY X-RADIOLYSIS OF METHANE IN SOLID ARGON. Keyser, Leon Frank. Pasadena, Calif., California Inst. of Tech., 1965. 184p.

Thesis.

The construction and operation of a low-temperature infrared cell are described; the cell is capable of maintaining temperatures between 7 and 50°K while in the light beam of a Beckman IR-7 spectrophotometer. Infrared spectra of HCl and DCl at 0.2 to 2% concentrations in solid krypton and xenon are reported. Fine structure in the region of the (1-0) vibrational transitions of HCl and DCl is assigned to monomeric and polymeric species of HCl and DCl. The monomer lines are assigned to vibration-rotation transitions of HCl and DCl. In krypton the R(0) transition of HCl occurs at 2872.7, R(1) at 2887, P(1) at 2837.4, and Q(0) at 2852.8 cm^{-1}. The R(0) transition of DCl in krypton occurs at 2078.9, R(1) at 2089, P(1) at 2058, and Q(0) at 2067.5 cm^{-1}. In xenon the R(0) transition of HCl occurs at 2858.2, R(1) at 2872, P(1) at 2825.5, and Q(0) at 2837.8 cm^{-1}. The R(0) transition of DCl in xenon occurs at 2069, R(1) at 2075, P(1) at 2047 and Q(0) at 2058 cm^{-1}. Besides a J-independent band origin shift with respect to the gas phase frequencies of −31 cm^{-1} in krypton and −44 cm^{-1} in xenon, the rotational levels of HCl exhibit J-dependent perturbations of 5 to 10 cm^{-1}. The band origin shift of DCl is −23 cm^{-1} in krypton and −33 cm^{-1} in xenon; the J-dependent perturbations of the DCl rotational levels lie between 1 and 3 cm^{-1}. Hindered rotation and libration of HCl and DCl in the rare gas crystals are not suitable descriptions of the J-dependent perturbations. A model based on the interaction of the rotational motion with the localized translational motion of HCl and DCl at substitutional sites in the rare gas crystals is used to interpret the J-dependent perturbations. The translational frequencies of HCl and DCl and the strength of the translation-rotation interaction are treated as parameters. The values of the translational frequencies which give the best fit to the observed rotational spacings are 36 cm^{-1} in xenon, 57 cm^{-1} in krypton, and 31 cm^{-1} in argon. The strength of the translation-rotation interaction as measured by the distance between the center of mass and the center of electrical symmetry in the molecule is 0.13 Å for HCl and 0.096 Å for DCl. A mechanism for the induction of a Q branch in the vibration−rotation spectra of monomeric HCl and DCl in the solid rare gases is discussed. The vibrational spectra of polymeric HCl and DCl are discussed in terms of dimeric and trimeric aggregates. The photolysis of ammonia in solid krypton with 1849 Å light or with x radiation gives rise to new absorption maxima at 1521, 1114, 1289, and 1280 cm^{-1} in the infrared. The line at 1521 cm^{-1} is assigned to the previously unobserved bending mode of the NH_2 radical. Experiments with isotopic ammonia show that the bending mode of ND_2 occurs at 1106 cm^{-1} in solid krypton. The CH radical is produced by X-radiolysis of methane in solid argon and krypton. The radiolysis mechanism is discussed in terms of energy transfer from the rare gas lattice to methane. (Diss. Abstr.)

Radiochemistry

4226 (BMwF-FBK-67-78) UNTERSUCHUNGEN UEBER DIE ANLAGERUNG VON NEUTRALEN UND ELEKTRISCH GELADE-

NEN EMANATIONS-FOLGEPRODUKTEN AN AEROSOLE (MESSUNG DES AEROSOL-GROESSENSPEKTRUMS, DES ANLAGERUNGSKOEFFIZIENTEN UND DER ANLAGERUNGSZEIT NEUTRALER ZERFALLSPRODUKTE). (Investigations on the Accumulation of Neutral and Electrically Charged Radon Decay Products in Aerosols (Measurement of the Aerosol Gross Spectrum, the Accumulation Coefficients, and the Accumulation Time of Neutral Decay Products)). Mohnen, V. (Munich Univ. (West Germany)). Sept. 1967. 24p. (In German)). Dep.

Large-scale measurements of attachment properties of neutral and electrically charged radon decay products to aerosols were carried out. The main objectives of these investigations were to determine the size distribution of an aerosol (a naturally occurring aerosol was used) in the submicroscopic range by means of a newly developed method and to measure the coefficient for attachment and the mean time for neutral decay product capture in a given aerosol mixture. (auth)

4227 (ANL-Trans-538) USE OF XENON DIFLUORIDE FOR THE SYNTHESIS OF LABELED PERIODATES. Kirin, I. S.; Isupov, V. K.; Tikhonov, V. I.; Ivannikova, N. V.; Gusev, Yu. K.; Selikhov, G. G. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Zh. Neorg. Khim., 12: 1088-9(1967). 4p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

A labeled potassium periodate was prepared by the interaction of potassium iodate labeled with the isotope ^{131}I and xenon difluoride. The formation of oxygen compounds of ^{131m}Xe during the β-decay of ^{131}I in the synthesized potassium periodate has been established. (auth)

4228 CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS IN SOLIDS. II. Gainar, I. Stud. Cercet. Chim., 14: 331-82(1966). (In Rumanian).

The Szilárd–Chalmers relaxation of atoms resulting from radioinduced nuclear transformations was investigated. The peculiar characteristics of relaxation processes as affected by various physical factors were analyzed: thermal relaxations, radio relaxation and photo relaxation, compression relaxation (compresso-relaxation), and uv-induced relaxation (sound relaxation). Within each relaxation process the kinetic aspects of relaxation were analyzed together with various theoretical models developed in order to explain the relaxation processes considered from a critical point of view. A general survey of the present stage of Szilárd–Chalmers processes and of their future prospects is presented. (Romanian Sci. Abstr.)

Separation Processes

Refer also to abstracts 4024, 4097, 4324, 4399, 4414, 4416, and 4418.

4229 (ANL-7347) LABORATORY INVESTIGATIONS IN SUPPORT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART XV. ESTIMATION OF RATES OF THERMAL DECOMPOSITION OF PLUTONIUM HEXAFLUORIDE IN PROCESS STREAMS. Trevorrow, L. E.; Steindler, M. J. (Argonne National Lab., Ill.). July 1967. Contract W-31-109-eng-38. 35p. Dep. CFSTI.

The need to predict rates of thermal decomposition of PuF_6 to PuF_4 and fluorine in fluoride volatility process streams has prompted a review of results of several types of experiments in which PuF_6 was thermally decomposed. The results of experiments with varying fluorine pressures and surface-to-volume ratios are correlated by a rate equation that expresses the dependence on those variables, $\ln(R_t - K_{eq}/R_0 - K_{eq}) = k't(s/v)$, in which R_0, R_t, and K_{eq} are the mole ratios of PuF_6 to F_2, initially, after a reaction period of t minutes, and at equilibrium, respectively. The dimensions of the surface-to-volume ratio (s/v) are expressed in cm^{-1}. The dimensions of the rate constant are expressed in cm min^{-1}, and the variation of the rate constant with temperature is expressed by the equation, $\log k' = (-3169/T(°K)) + 5.364$. The latter two equations are recommended for prediction of the rate of thermal decomposition of PuF_6 in process streams in which the partial pressure of fluorine is significantly high. (P.C.H.)

4230 (EURAEC-1920) REPROCESSING OF IRRADIATED FUELS. Quarterly Report No. 27, October 1–December 31, 1966. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Contracts 006-65-7-RCIB(RD); 016-65-1-RAP-B. 46p. (EUR-3751). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

Chemical decanning tests were carried out on stainless steel, using a mixture of hydrogen fluoride and oxygen, in order to clarify the influence of the concentration of the reagents. Satisfactory rates of stainless steel destruction were obtained for hydrogen fluoride concentrations ranging between 40 and 65%. Where atomization of the UO_2 fuel is required at the same time, a concentration of about 65% of the same reagent appears wholly adequate. With higher concentrations there is a slower rate of stainless steel attack, and the compact uranium dioxide tends to remain unaffected. Prior to this, laboratory tests were effected to assess the value of chlorine trifluoride/fluorine cycles in reprocessing mixed uranium and plutonium dioxides that have been atomized beforehand. Analysis of the results showed: relatively high yields for plutonium fluorination; very high uranium yields; and a very unfavorable effect of grain sintering during processing with fluorine. In addition, the presence of fission products or too substantial a plutonium residue, and an excessive initial temperature for fluorination, seem to hinder plutonium volatilization and increase plutonium retention on the fluid bed. Kinetic studies on the volatilization of plutonium tetrafluoride with chlorine trifluoride clarified the mechanism of the reaction. Thermogravimetric tests did not reveal any volatilization of plutonium by chlorine trifluoride below 300°C. A similar method was adopted to confirm the selectivity of chlorine monofluoride in relation to uranium at high temperatures. Chlorine monofluoride was found to be a very active agent for $PuO_2 - PuF_4$ transformation. The gases formed during the reactions between chlorine monofluoride and UF_4, UO_2, and U_3O_8 were analyzed. Above 300°C, U_3O_8 was alone in continuing to form ClO_2F in addition to chlorine and oxygen. Variance analysis was applied to several reactions performed in a fluid bed. Other technological tests showed that, during the reaction between the $UF_4 - UO_2F_2$ mixture and chlorine monofluoride, the reaction rate is a linear function of the concentration (between 15 and 50%). It was also found that U_3O_8 could react with chlorine monofluoride at relatively satisfactory rates, in view of the low fluorine content in this inter-halogen. (P.C.H.)

4231 (IN-1087) CHEMICAL TECHNOLOGY BRANCH ANNUAL REPORT, FISCAL YEAR 1967. Bower, J. R. (ed.) (Idaho Nuclear Corp., Idaho Falls). Oct. 1967. Contract AT-(10-1)-1230. 129p. Dep. CFSTI.

Research progress is reported on: performance of ICPP fuel recovery processes, support studies for current ICPP fuel recovery processes, graphites fuel reprocessing, the Idaho waste calcining facility, advanced waste calcination studies, properties of solid calcined waste, heat transfer studies affecting the calcination process and storage of the calcined product, additional waste management studies, LOFT assistance program, other reactor technology support programs, and new modular pilot plant laboratories. (M.C.G.)

4232 (K-L-1979) REMOVAL OF RADIOACTIVELY GENERATED HEAT IN FLUORIDE VOLATILITY REPROCESSING OPERATIONS. Dunthorn, D. I. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Mar. 17, 1965. Contract W-7405-eng-26. 23p. Dep. CFSTI.

Information about temperature effects in fluoride volatility processing operations was obtained through the theoretical investigation of several important cases. The first case is a module in air. Two more cases involve the module after placement in a fluidized-bed declading reactor; first, when a module has become plugged with caked fluidizing media during treatment, and second, when a module is covered with the settled media during a shutdown of the process. An evaluation was also made of temperature rise problems in settled-bed material. Results of calculations are presented. (M.C.G.)

4233 (K-L-6167-S) REMOVAL OF IMPURITIES FROM URANIUM HEXAFLUORIDE BY SELECTIVE SORPTION TECHNIQUES. Smiley, S. H.; Pashley, J. H.; Kaufman, H. L.; Stephenson, M. J.; Merriman, J. R. (Oak Ridge Gaseous Diffusion Plant, Tenn.). [nd]. Contract W-7405-eng-26. 13p. (CONF-671102-36). Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

Methods are being developed for removing volatile impurities from UF_6 with emphasis on the use of solid compounds that are effective sorbents for impurities present in the ppM range but that do not retain significant quantities of uranium. Engineering-scale flow tests are being carried out on sorption traps. (M.C.G.)

4234 (RT/CHI-(67)8) UNIRRADIATED MTR FUEL ELEMENTS DISSOLUTION IN SEMICONTINUOUS FLOODED DISSOLVERS FOR ACID AND ACID-DEFICIENT FINAL CONDITIONS. Beone, G.; Lojacono, R.; Mazzoleni, G. P.; Moccia, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 24p. Dep.

Studies of mercury-catalyzed nitric acid dissolution of unirradiated MTR fuel elements in acid and acid-deficient conditions were

carried in a flooded semicontinuous dissolver on laboratory and pilot scales. This type of dissolver will be used in the Eurex plant. Several series of runs were made using varying feed acid concentrations in which all factors were constant or using a varying acid feed flow rate or catalyst concentration to correlate these process parameters with metal dissolving rate and product concentrations. Under all conditions the metal dissolving rate was directly proportional to the 0.87 power of the nitric acid feed molar rate and to the 0.42 power of catalyst concentration except in a short range. This dissolution time decreased with increasing catalyst concentration and the dissolution product changes from an acid to acid-deficient condition. (auth)

4235 (ORNL-tr-1829) DETERMINATION OF DISTRIBUTION COEFFICIENT FOR THE $(CH_3)_2O.BF_3$ COMPLEX EXCHANGE-DISTILLATION PROCESS. Kaminskii, V. A.; Karamyan, A. T.; Partsakhashvili, G. L. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from At. Energ. (USSR), 23: 244(1967). 2p. DTIE.

The distribution resulting from dissociation of $(CH_3)_2O \cdot BF_3$ vapor into BF_3 and methyl ether is determined by the effective coefficient, which is related to the equilibrium constant of the isotope exchange reaction. Variation of the equilibrium constant with temperature is shown and at 100°C the value was 1.018, while the value for the distribution coefficient was 1.011. (M.C.G.)

4236 LIQUID–LIQUID EXTRACTION METHODS FOR THE PRODUCTION OF CARRIER-FREE ^{115}Cd, ^{89}Sr, AND ^{90}Sr FROM FISSION PRODUCTS. Mirza, M. Y. (Atomic Energy Commission, Riso, Denmark). Anal. Chim. Acta, 40: 235-40(Feb. 1968).

The extraction of fission product elements with 1-phenyl-3-methyl-4-caprylpyrazolone-5 at various pH values has been investigated. The quantitative extraction of cadmium at pH 5.4 and that of strontium at pH 9.0 is utilized in devising procedures for the recovery of ^{115}Cd and $^{89,90}Sr$ from the fission products. Good decontamination factors and more than 90% ^{115}Cd and 80% $^{89,90}Sr$ activities were recovered. (auth)

4237 A NEW METHOD FOR THE CARRIER-FREE PRODUCTION OF ^{90}Y FROM ^{90}Sr–^{90}Y MIXTURE AND ^{89}Sr FROM NEUTRON-IRRADIATED Y_2O_3. Mirza, M. Y. (Atomic Energy Commission, Riso, Denmark). Anal. Chim. Acta, 40: 229-33 (Feb. 1968).

The extraction of strontium(II) and yttrium(III) ions from aqueous solutions at various pH values into methyl isobutyl ketone containing 1-phenyl-3-methyl-4-caprylpyrazolone-5 is described. Quantitative extraction of Sr and Y at pH 8.6 to 10 and pH 2.8 to 5.4, respectively, is utilized for the carrier-free production of ^{90}Y from $^{90}Sr-^{90}Y$ mixtures and ^{89}Sr from neutron-irradiated yttrium oxide. A clean separation of these elements from each other and more than 95% calculated activities were recovered. (auth)

4238 AQUEOUS BICARBONATE–OXALATE AS LEACHING REAGENT FOR JAPANESE URANIUM ORES. Funaki, Koemon; Ishijima, Itaru (Tokyo Inst. of Tech.). Kogyo Kagaku Zasshi, 69: 1844-9(Sept. 1966). (In Japanese).

An efficient process of high selectivity is proposed for leaching uranium from Ningyotoge secondary uranium ores, mainly Autunite. Uranium can be readily leached with an aqueous bicarbonate. The leaching rate and the selectivity increase on addition of an oxalate to the bicarbonate reagent, and the extent of this rate increase varies with cations in the order: $K^+ > Na^+ > NH_4^+$. A part of uranium can be leached out using an oxalate solution alone. In case of the sodium salt, the optimum composition of the reagent is that containing about 4.5% $NaHCO_3$ and 3% $Na_2C_2O_4$. Leaching yield increased with temperature, and at 100°C the leaching appeared to be sufficient in 5 hr, while the leaching yield varied with the type of ore and was 80 to 90% or above. A grain size of −2000 mesh was enough for effective leaching, and the pulp density can be raised up to 50% without any substantial decrease in yield. Maximum leaching is attained when the leached liquor has a pH of about 10.5. The ores used can be classified into two types, i.e., soluble type and less soluble type. The leaching yield of uranium in the present process does not differ significantly from that of the ordinary process using sulfuric acid or carbonate. (NSA of Japan)

4239 ENRICHMENT OF LITHIUM ISOTOPES BY MEANS OF ELECTROMIGRATION USING A CATION EXCHANGE MEMBRANE AND A RESIN. Okamoto, Makoto (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 76, 143-8(Mar. 1966).

An ion-exchange membrane and a resin were employed as the medium for electromigration separation of lithium isotopes. The ion-exchange membrane gave the $(V_6-V_7)/V_{Li}$ value 0.008. Semicontinuous separation was tried, but was shown to be rather difficult. Two kinds of separation equipment were designed and operated with a unique process for 30 to 45 days. (NSA of Japan)

4240 REMOVAL OF IMPURITIES FROM URANIUM HEXAFLUORIDE BY SELECTIVE SORPTION TECHNIQUES. Smiley, S. H.; Pashley, J. H.; Kaufman, H. L.; Stephenson, M. J.; Merriman, J. R. (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc., 10: 507(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4241 ANION EXCHANGE SEPARATION OF CALCIUM, STRONTIUM, AND BARIUM WITH MIXED ELUENTS. Kurokawa, Kazuo (Tokyo Metropolitan Hakuo Senior High School). Nippon Kagaku Zasshi, 88: 1171-6(Nov. 1967). (In Japanese).

Calcium, strontium, and barium were separated by a column of anion exchange resin Amberlyst-A29, using dilute nitric acid containing water-miscible alcohol and potassium nitrate as an eluting solution. The mixtures, MeOH−isoPrOH−7 mol./l NHO_3−1 mol./l KNO_3−H_2O(volume ratio: 60:30:5:2:3), MeOH−7 mol./l HNO_3−1 mol./l KNO_3−H_2O(90:5:2:3) and 0.1 mol./l HNO_3 were used for the elution of calcium, strontium, and barium, respectively. It was found that these metals are adsorbed as $Ca(NO_3)_4^{2-}$, $Ca(NO_3)_3^-$, $Sr(NO_3)_4^{2-}$, $Sr(NO_3)_3^-$, and $Ba(NO_3)_3^-$ on the anion exchange resin. In preparation of the sample solutions the chloride salts were dissolved in MeOH−HCl. This method was found to be effective for the rapid separation of Ca, Sr, and Ba up to 0.12 mmol. Although calcium is first separated from others by passing 40 ml of the eluting solution, double peaks are found in the elution curve of calcium with MeOH−isoPrOH−HNO_3−KNO_3−H_2O. (auth)

4242 ISOTOPE SEPARATION BY MULTIPLE CONTACT. II. ANALYTICAL PROCEDURE FOR FRONTAL PROCESS. Shimokawa, Junichi; Kobayashi, Fumiaki (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 570-77(Nov. 1967).

An analytical procedure for the frontal process was developed for the case in which: the mobile fluid phase proceeds stepwise from one contacting unit to the next, isotopic exchange equilibrium is attained between the mobile and stationary phases in all the units, and chemical refluxing occurs always at the frontal edge of the region containing the fluid phase. Equations were derived for the isotopic abundance ratio of a chemical substance at any refluxing unit and for the early part of a breakthrough curve. It was possible to obtain an approximate estimate for the separation factor and for the number of contacting units when a breakthrough curve was drawn from experiment. Finally, a comparison of the frontal process with the reverse frontal process was made with some numerical examples. (auth)

4243 PROBLEMS IN THE REPROCESSING OF SPENT NUCLEAR FUEL IN JAPAN. Haginoya, Toru. Genshiryoku Kogyo, 13: No. 4, 4-8(Apr. 1967). (In Japanese).

The problems in reprocessing nuclear fuel in Japan are described, centered on a reprocessing facility with a capacity 200-tons uranium reprocessing per year to be constructed. Topics covered include: the nation's basic policy for spent fuel reprocessing, planning for construction of the reprocessing plant, spent fuels for reprocessing, raising funds for plant construction and charges for reprocessing, problems connected with international agreements, safety in the reprocessing facility, and the future for the nation's spent fuel reprocessing. (NSA of Japan)

4244 ELECTROLYTIC FRACTIONATION OF CALCIUM ISOTOPES USING A STREAMING MERCURY CATHODE. Kishima, Noriaki; Honda, Masatake (Tokyo Univ.). Shitsuryo Bunseki, 14: No. 5, 251-6(Dec. 1966). (In Japanese).

Electrolytic fractionation of calcium isotopes was studied using a streaming mercury cathode in relation to the cell potential. Isotopic ratios were measured by a mass spectrometer. Increasing separation factor with decreasing cell potential was observed and an upper limit for the separation factor was estimated by extrapolation as 1.013, which was expected to be obtained at the isotopic exchange equilibrium. Possible mechanisms of fractionation are discussed. (NSA of Japan)

4245 REMOVAL OF FISSION PRODUCTS AND THEIR COMPLEXING AGENTS BY POTASSIUM DISHROMATE METHOD FROM KEROSENE DEGRADED WITH NITRIC ACIDS. Ohwanda, Ken (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 560-4(Nov. 1967).

A washing method using potassium dichromate as oxidizing reagent was applied to remove fission products and their complexing agents from kerosene degraded with nitric acid. The fission products and their complexing agents were both effectively removed from the degraded kerosene, their removal percentage increasing with rising concentration of sulfuric acid and potassium dichromate. The removal percentage of fission products also increased slightly with shaking time of the mixture of degraded kerosene and

acidic potassium dichromate solution. Change in volume ratio (O/A) however hardly affected the removal percentage. Lowering of the absorption bands due to carboxylic acids, nitrate esters, and nitro compounds were observed in the infrared spectra of the degraded kerosene treated with acidic solution of potassium dichromate. Infrared analysis of TBP/kerosene treated with acidic potassium dichromate solution showed that no chemical degradation of the solvent occurred to any extent. (auth)

4246 DISTRIBUTION-CHROMATOGRAPHIC METHODS FOR SEPARATING Mo, W, AND Re AND THEIR USE IN THE ANALYSIS OF THE RADIOISOTOPIC PURITY OF RADIOACTIVE PREPARATIONS OF THESE ELEMENTS. Moskvin, L. N.; Shur, L. I.; Tsaritsyna, L. G.; Martysh, G. T. Radiokhimiya, 9: 377-81(1967). (In Russian).

The extraction of Mo, W, and Re with n-amyl alcohol, amyl acetate, methyl isobutyl ketone, and tributyl phosphate from mixed solutions of tartaric and hydrochloric acid was investigated. A scheme for the distribution-chromatographic separation of Mo, W, and Re and of Mo and Tc is proposed. (tr-auth)

4247 THE SEPARATION OF THORIUM AND CERIUM BY LIQUID-LIQUID EXTRACTION. APPLICATION TO THE HYDROMETALLURGICAL TREATMENT OF THORIUM MINERALS. Collee, R. RUM, Rev. Universelle Mines, 108: 329-39(Oct. 1965). (In French).

Present methods of metallurgical treatment of Th minerals generally are based on operations that are particularly delicate or onerous. In connection with studies of hydrometallurgy of monazites, liquid-liquid extraction was employed; the chief solvents and complexons studied were thenoyltrifluoroacetone–benzene, bis(2-ethylhexyl) phosphate–benzene, and sodium diethyldithiocarbamate–benzene. Separation coefficients for Th in the organic phases are large in nitrate solutions free of acid, while the Ce remains mostly in the aqueous phase. These results are considerably modified, and even inverted, in acid solution. A multistage study shows that selective separation of Th may be achieved with high yields in a small number of steps, and the application of the method to certain monazite minerals appears particularly useful in the treatment of thoriferous minerals. (BBB)

4248 SEPARATION OF METAL IONS ON STANNIC PHOSPHATE AND STANNIC TUNGSTATE PAPERS. SPECIFIC SEPARATIONS OF Au(III), Hg(II), Pt(IV), Mg(II), Mo(VI), AND Se(IV). Qureshi, Mohsin; Akhtar, Iqbal; Mathur, K. N. (Aligarh Muslim Univ., India). Anal. Chem., 39: 1766-70(Dec. 1967).

Mixed solvents were effectively used to obtain analytically difficult separations of cations by chromatography on stannic phosphate and stannic tungstate papers. The separations achieved include: Au^{3+}, Sb^{3+}, Sb^{5+}, Pd^{2+}, Hg^{2+}, Pt^{4+}, As^{3+}, K^+, Rb^+, Cs^+, Mg^{2+}, Zr^{4+}, Mo^{6+}, UO_2^{2+}, Ag^+, and Se^{4+} from numerous metal ions and Al^{3+}–Be^{2+}–Fe^{3+}; Tl^{4+}–V^{4+}–Fe^{3+}; K^+–Cs^+; Au^{3+}–Pd^{2+}–Pt^{4+}; Cu^{2+}–Cd^{2+}; Sb^{3+}–Sb^{5+}; Ca^{2+}–Ba^{2+}; Mg^{2+}–Sr^{2+}–Ba^{2+}; UO_2^{2+}–V^{4+}–Mo^{6+}; Ag^+–Pt^{4+}–Au^{3+}; Ag^+–Tl^+–In^{3+}; Ce^{3+}–Ce^{4+}; Hg_2^{2+}–Hg^{2+}; Pt^{4+}–Au^{3+}–Ir^{4+}; Pd^{2+}–Au^{3+}; Ir^{4+}. (auth)

4249 NEW METHOD FOR RAPID SEPARATION OF BERKELIUM(IV) FROM CERIUM(IV) BY ANION EXCHANGE. Moore, Fletcher L. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Anal. Chem., 39: 1874-6(Dec. 1967). (ORNL-P-3385).

A simple, sharp, quantitative separation of ^{249}Bk from ^{144}Ce present in the tetravalent oxidation states in nitric acid solution is reported, based on their drastically different sorption behavior in the system described. (auth)

4250 EFFECT OF TEMPERATURE ON RADIOCHEMICAL SEPARATION OF ALKALI METALS ON SULPHONIC AND PHENOLSULPHONIC ION EXCHANGERS. Dybczynski, Rajmund (Inst. of Nuclear Research, Warsaw). Nukleonika, 12: 927-39 (1967).

The separation of alkali metals on Amberline IR-120, and on the MK-3 phenolsulfonic ion exchanger was investigated at various temperatures. For both resins the separation factors decreased with increasing temperature. The height of the theoretical plate was found to increase with increasing temperature. The phenolsulfonic resin showed high selectivity towards cesium, and may therefore be used for isolating traces of cesium from macroamounts of lighter alkali metals. It was observed, however, that this high selectivity vanishes irreversibly at elevated temperatures. (auth)

4251 URANIUM(VI) EXTRACTION FROM SULPHURIC ACID SOLUTION WITH TRI-N-HEXYL- AND TRI-N-DECYLAMINE SULPHATE SOLUTIONS IN BENZENE. Deptula, Czeslaw (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 12: 941-7(1967).

The effect of the concentrations of sulfuric acid, uranyl sulfate, and extractant on uranium(VI) extraction with tri-n-hexyl- and tri-n-decylamine was investigated. The composition of the extracted compounds was determined to be $[4R_3NH^+; UO_2(SO_4)_3^{-4}]$, and the absorption spectra of the compounds are given. (auth)

4252 FRACTIONATION OF BORON ISOTOPES BETWEEN BORON TRIFLUORIDE AND ITS MOLECULAR ADDITION COMPOUNDS. Palko, A. A.; Drury, J. S. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 47: 2561-6(Oct. 15, 1967).

Boron trifluoride adds to many Lewis bases to form 1:1 molecular addition compounds. Under favorable conditions, some of these adducts may be used to fractionate the isotopes of boron by means of the following reaction: Donor · $^{11}BF_3$(l) + $^{10}BF_3$(g) = Donor · $^{10}BF_3$(l) + $^{11}BF_3$(g). The equilibrium constants for this reaction vary with donor, donor substituents, and temperature. At 30°C the following order was observed: $(C_2H_5)_2S$ > $(CH_3)_2S$ > $(CH_3)_2Se$ > $(C_4H_9)_2S$ > $(C_2H_5)_2O$ > $C_6H_5OCH_3$ > $(CH_3)_2O$ ≥ $(CH_2)_4O$ > C_6H_5OH > $(C_2H_5)_3N$. The "anomalous" concentration of ^{10}B in the molecular addition compound may be explained by the unique chemistry of the boron and fluorine atoms. A model is proposed that accounts for observed variations in the isotopic fractionation factor when different donors are used, as well as when different substituents are present on a selected donor. The model also explains the isotopic behavior of other boron halides. (auth)

4253 THE JUAN VIGON CENTER OF NUCLEAR ENERGY. THE CIES PILOT PLANT FOR THE TREATMENT OF RADIOACTIVE LIQUID WASTE. I. THE LOW RADIOACTIVITY CIRCUIT. de Lora Soria, Federico; Lopez Perez, Baldomero (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 11: 184-9(May-June 1967). (In Spanish).

The low-activity circuit of the "CIES" pilot plant for processing of radioactive liquid waste is described. The process used is known as the water recycle process and the flow diagram is given. The equipment installed is briefly summarized. (J.S.R.)

4254 ISOTOPIC EFFECTS IN REACTIONS OCCURRING IN ELECTRIC DISCHARGES. Semiokhin, I. A. (Moscow State Univ.). Isotopenpraxis, 3: 364-7(Sept. 1967). (In Russian).

Synthesis and dissociation of molecules in electric discharges (as of ozone, carbon dioxide, ammonia) are associated with kinetic (and, in a lower degree, thermodynamic) isotopic effects resulting in the enrichment of the heavier isotopes ^{13}C, ^{15}N, and ^{18}O in the undissociated molecules. Isotopic exchange between the different molecules in the discharges (as between CO_2 and H_2O (steam) or between CO_2 and O_2) takes place very rapidly and is associated with thermodynamic (and, in some degree, kinetic) isotopic effects. (auth)

4255 SOME PHYSICO-CHEMICAL PROPERTIES OF CHLORIDES OF U, Pu, Am, AND Cm IN FUSED SALTS. Borkowska, Z.; Gutniak, S.; Mielcarski, M.; Taube, M. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 31-41 (1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

The distribution of U, Pu, and Am between a KCl–CuCl eutectic melt and an organic phase (TBP, HDBP, and TOA diluted by diphenyl) was investigated at 180°C. Distribution ratios were determined for U(IV), U(III), Pu(IV), Pu(III), and Am(III), and for components of the salt phase i.e., Cu(I), K, and Cl. From the results obtained the structure of the complexes formed between the investigated elements and the extractants as well as the ionic composition of the salt phase is suggested. The direction of electromigration of ions in molten CuCl–KCl eutectic mixture containing UCl_4 and $PuCl_3$ was measured. Radiotracers of fused salt components were used. From radioactivity measurements of aliquot samples in the anodic and cathodic compartments the rates of cathodic migration for the ions were calculated and some suggestions concerning the degree of complex formation made. The visible absorption spectra of U(IV) in HCl, in organic solvents, and in fused chlorides were determined and the electronic transitions $^3H_4$–$^3P_2$, $^3H_4$–$^1I_6$, $^3H_4$–$^3P_1$ and $^3H_4$–$^1D_2$ or $^3H_4$–$^1G_4$ within the 5f shell were identified. The ligand's field influence on U(IV), especially the extent of covalent bonding, by means of multiplet splitting parameter ζ and the shift of absorption bands was examined. (auth)

4256 URANIUM CONCENTRATE PLANT AT KOWARY. Wyszkowski, Tadeusz (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 243-9(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Considerations on which the decision to build first Polish U concentrate plant was based are given. Chemical technology and organization of the plant to be built are described. The present state of investment and cooperation between the Institute of Nuclear Research and a managing group in designing, supervising

of the construction, and preliminary runs of the plant are discussed. (auth)

4257 TECHNOLOGICAL RESEARCHES ON CONTINUOUS COUNTERCURRENT SOLVENT EXTRACTION OF URANIUM. Modrzew, J.; Golinski, M. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 251-67(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Results of researches on U extraction with TBP and TOA in half technical scale are given. Construction of the installation applied in both processes is described. Efficiency of apparatus and purity of products were satisfactory. (auth)

4258 RECOVERY AND PURIFICATION OF URANIUM AND OTHER METALS BY ION EXCHANGE AND SOLVENT EXTRACTION. Korpak, W.; Urbanski, T. S.; Deptula, Cz.; Majchrzak, K.; Golinski, M.; Modrzew, J.; Borysowski, J. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 269-73(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Investigations of the extraction of uranyl nitrate with ether and TBP and works on liquid anion and cation exchange extraction and/or anion exchange of U, Cr, Ce, and other metals are reviewed. Recent developments in the application of solvent extraction to some hydrometallurgical processes are described. (auth)

4259 NEW URANIUM ORE PROCESSING METHOD. Adamski, T.; Pinkas, K.; Wyszkowski, T.; Panas, J. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 275-8 (1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

A simplified U ore concentration method with the aid of H_2SO_4 is described. The method enables shortening by 20 to 40 times the time of extraction, and decreasing the size of the equipment by the same factors. The construction of leaching apparatus provides means for separation of the solid phase into two fractions that undergo further treatment separately. A continuous ion-exchange apparatus is proposed. Proper organization as well as automation results in further investment and processing costs reduction. (auth)

4260 INVESTIGATIONS ON STABLE ISOTOPES. Selecki, A. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 333-8(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

A review is presented of studies of chemical engineering related to stable isotope problems. Investigations were carried out on isotope exchange reactions on the macrokinetics of contact processes and some fluidization problems. Results of the investigation of isotope separation processes may be adapted to conventional chemical technology. (auth)

4261 REGULARITIES IN ISOTOPIC EXCHANGE THERMODYNAMICS. V. POSSIBILITY OF ISOTOPIC SEPARATION OF MEDIUM AND HEAVY ELEMENTS BY CHEMICAL EXCHANGE. Knyazev, D. A.; Bantysh, A. N.; Ivlev, A. A. (Moscow Inst. of Chemical Tech.). Zh. Fiz. Khim., 41: 2200-5(Sept. 1967). (In Russian).

On the basis of the previously determined value of the ratio of the sum with respect to the state of the isotopic form of multiatom molecules, an evaluation was made on the possibility of using the chemical exchange method for separation of isotopes of average and heavy elements. The attainable values of the coefficients of separation of isotopes of elements of periods 3 to 5 and groups 4 to 8 of the periodic system were found. Up to mass number 100 (the last elements of the fourth period) the chemical exchange method in separation of isotopes in significant quantities must have greater regularities than the gas diffusion method. (tr-auth)

4262 SEPARATION OF NIOBIUM AND TITANIUM BY FROTHING METHOD. Savel'ev, V. N.; Skrylev, L. D.; Mokrushin, S. G. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Prikl. Khim., 40: 1741-3(Aug. 1967). (In Russian).

An effective method was found for the separation of Nb and Ti by separation of high-dispersion niobium hydroxide from solutions by direct hydrolysis of hydrochloric acid solutions of Nb and Ti. (R.V.J.)

4263 MACHINE TOOL FOR CUTTING AN ASSEMBLY OF COAXIAL TUBES INTO PARTS, PARTICULARLY THE CHANNELS OF A PRESSURE-TUBE NUCLEAR REACTOR. Di Piazza, Learco; Leroy, Rene; Monzani, Ermelino (to European Atomic Energy Community). British Patent 1,087,886. Oct. 18, 1967. Priority date Apr. 16, 1964, Belgium.

A cutting-wheel machine tool is described that is particularly applicable to cutting into parts the coaxial tubes used in heavy water-moderated, organic-liquid-cooled reactors. The tool comprises at least three co-planar rotatable cutting discs supported around and equidistantly from a common axis, which is in use the axis of the tubes to be cut, and is perpendicular to the plane containing the discs. Each disc has a beveled cutting edge and is of gradually increasing thickness from the edge inwardly towards the center of the disc. The discs may be displaced towards and away from the axis and may be rotated around the axis between the discs and tubes to be cut. (B.L.M.)

4264 DOUBLE PULSED MIXER-SETTLER LIQUID–LIQUID EXTRACTION SYSTEM. McHenry, Raymond E.; Posey, J. C. (to U. S. Atomic Energy Commission). U. S. Patent 3,360,340. Dec. 26, 1967.

A pulsed mixer-settler system for carrying out a liquid–liquid extraction process is described. This system comprises a series of vertically disposed elongated mixing vessels interconnected by angularly disposed elongated settling vessels. The mixing vessels are provided with liquid outlet ports at their midpoints, which communicate with inlet ports of the settling vessels. Means are provided for introducing a first pulse into the top of each mixing vessel and a second pulse, 180° out of phase with the first pulse, into the bottom of each mixing vessel. (AEC)

4265 IMPROVEMENTS IN OR RELATING TO THE DEIONISING OF SOLUTIONS. Kennedy, John; Peckett, John William Alfred; Perkins, Ronald (to United Kingdom Atomic Energy Authority). British Patent 1,090,051. Nov. 8, 1967. Filed Sept. 11, 1964.

A process for deionizing an aqueous solution by contacting the solution with hydrated titanium oxide is described for application to the decontamination of radioactive waste solutions. The solution is passed through a column of granules of the material. Special applications to the recovery of Ru from alkaline waste solutions and to recovery of Pu(IV) from sodium carbonate solutions are described. (B.L.M.)

4266 RECOVERY OF URANIUM AND/OR PLUTONIUM FROM SOLUTION. Stevenson, David Gordon (to United Kingdom Atomic Energy Authority). British Patent 1,087,322. Oct. 18, 1967. Filed Mar. 20, 1964.

A process for the continuous precipitation of U and/or Pu into a precipitation zone and introducing a base from without the precipitation zone in the presence of an aliphatic C_1 to C_3 monocarboxylic acid, which is present in an amount sufficient to form a complex ion with the metal ions of each of the salts but insufficient to precipitate the salt of the acid with the metal ion in the absence of the base. The preferred salt of U for the process is uranyl salt, but the Cl^- and NO_3^- may be used. Pu is preferably present in the tetravalent form. The pH of the solution is maintained at pH 5 to 6. The preferred acid is acetic, which is present in the range from 0.1 to 0.5 N. (B.L.M.)

4267 PROCESS FOR DECANNING NUCLEAR FUEL ELEMENTS. Peray, Robert (to Commissariat a l'Energie Atomique). British Patent 1,088,978. Oct. 25, 1967. Priority date Mar. 31, 1965, France.

A method of decanning fuel elements consists of dissolving the canning material in Hg, recovering the fuel after complete dissolution of the canning material, and then regenerating the Hg by separating the constituents of the resulting solution by distillation of the Hg. (B.L.M.)

4268 IRRADIATED FUEL REPROCESSING. Anderson, C. R. (to General Electric Co.). Canadian Patent 755,544. Mar. 28, 1967.

The irradiated reactor fuel was subjected to a single cycle extraction with an organic solvent in the presence of an aqueous salting agent. This reactor produced an organic extract stream containing substantially all the fissionable-fertile isotope values and a minor proportion of fission products such as Ru, Zr, and Ni. The organic extract was further treated to remove fissionable-fertile isotope values except U and certain lighter fission products. Dehydration formed anhydrous solids. Fluorination of the solids allowed a separation of the relatively low-boiling UF_6 from other high-boiling fission product fluorides. Close control of pH at one stage of the process was an important feature. (F.S.A.)

4269 REMOVAL OF ^{90}Sr FROM MILK WITH CALCIUM PYROPHOSPHATE, STRONTIUM PYROPHOSPHATE, OF MIXTURE THEREOF. Van't Riet, B. (to U. S. Atomic Energy Commission). U. S. Patent 3,359,117. Dec. 19, 1967.

A process for removing radioactive strontium from milk with an inorganic salt selected from the group consisting of strontium pyrophosphate, calcium pyrophosphate, and their mixtures is described. The inorganic salts are absorbed upon silica-alumina porous pellets, thereby removing the radioactive strontium from the milk. (AEC)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstract 4296.

4270 (CEA-R-3298) LA METHODE NEUTRONIQUE DE MESURE DE L'HUMIDITE DES SOLS. (The Neutronic Method for Measuring Soil Moisture). Couchat, Philippe (Commissariat a l'Energie Atomique, Cadarache (France). Centre d' Etudes Nucleaires). July 1967. 29p. (In French). Dep.

The three group diffusion theory was chosen as the best method for determining the response of the neutron soil moisture probe. A mathematical model was designed using a numerical calculation program with Fortran IV coding. This model is fitted to the experimental conditions by determining the effect of different parameters of the measuring device such as channel, fast neutron source, detector, soil behavior under neutron irradiation, absorbers, and chemical binding of elements. The adequacy of the model was tested by fitting a line through the image points corresponding to the couples of experimental and theoretical values, for seven media having different chemical composition such as sand, alumina, lime stone, dolomite, kaolin, sandy loam, calcareous clay. The model chosen gives a good expression of the dry density influence and allows α, β, γ and δ constants to be calculated for a definite soil according to the following relation which gives the count rate of the soil moisture probe: $N = (\alpha\rho_s + \beta)H_v + \gamma\rho_s + \delta$. (tr-auth)

4271 (RLO-1725-107) MIXING OF COLUMBIA RIVER AND OCEAN WATERS, SUMMER. Conomos, T. John; Gross, M. Grant (Washington Univ., Seattle. Dept. of Oceanography). Oct. 1967. Contract AT(45-1)-1725. 31p. (CONF-670832-1). Dep. CFSTI.

From National Symposium on Estuarine Pollution, Stanford, Calif.

Recent research on circulation and mixing of the waters of the Columbia River and the Pacific Ocean is reviewed. Attention is focused on circulation and mixing near the river mouth and factors controlling the supply, distribution, and utilization of plant nutrients such as nitrates, inorganic phosphates, and reactive silicates. In summer, silicate-rich but nitrate-poor river water mixes with nitrate- and phosphate-rich subsurface ocean water drawn into the estuary. The resulting nitrate-enriched low-salinity water supports enhanced primary productivity in the surface ocean near the river. Nitrate depletion occurs within 30 Km of the river mouth. (F.S.)

4272 (TID-24140) TRANSPORT OF RADIONUCLIDES WITH SUSPENDED SEDIMENT IN ESTUARINE SYSTEMS. Klingeman, Peter C.; Kaufman, Warren J. (California Univ., Berkeley). Sept. 1965. Contract AT(11-1)-34. 222p. (SERL-65-15). Dep. CFSTI.

The transport of the radionuclides with suspended sediment in estuary systems was studied. Factors affecting the changing distribution of radionuclides in the waters and sediments were determined. By labeling large masses of river suspended sediments with fallout fission products, the transport, deposition, and redistribution of river suspensions within portions of the San Francisco Bay system were followed. (F.S.)

4273 RADIOISOTOPE GAGE FOR DETERMINING SUSPENDED-SEDIMENT CONCENTRATION IN STREAMS. Gerrard, Martha. Radiat. Technol., 4: 358-62(Summer 1967).

An internally powered, self-referencing gage was developed for determining suspended-sediment concentrations in water of 1000 to 50,000 ppM to an accuracy better than ±20%. The measuring head, containing a ^{109}Cd source, was mounted under water, and the attenuation of the emitted x radiation by the sediment-laden water was compared with that by distilled water. Data were recorded by a shore based unit. The source must be replaced about once a year. Its activity was such that no special procedures or markings were required in shipping and handling and no AEC license was required for use. The major system components were light enough to be carried by one man. (auth)

4274 SPANISH URANIUM AREAS. Liarte, Julio (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 11: 193-9(May-June 1967). (In Spanish).

Certain U-rich areas in Spain are reserved for exploitation by the government. The actual extent of these reserves and their characteristics and boundaries are described in detail. The evolution of the governmental claims to these reservations is outlined. (J.S.R.)

4275 THE CONTAMINATION BY ^{90}Sr OF SOILS IN SOUTHERN POLAND. THE DEGREE OF CONTAMINATION BY ^{90}Sr SOILS IN VOIVODSHIP, KRAKOW, AND SOUTHERN DISTRICTS OF VOIVODSHIP, KATOWICE, AND WROCLAW IN 1962. Litynski, T.; Domnicz, A.; Godek, J.; Gorlach, K. Nukleonika, 10: Suppl., 113-21(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10-12, 1964. See CONF-640210.

^{90}Sr was determined in 208 soil samples by the ferrous-yttrium method. The degree of the soil contamination was equal to 21.3 ± 8.3 mCi/km^2. Some interdependence was shown to exist between contamination and atmospheric fallout (snowfall, rainfall etc.) and elevation. (auth)

4276 POTASSIUM-ARGON AGES OF IRON METEORITES. Rancitelli, Louis Albert. Ithaca, N. Y., Cornell Univ., 1967. 90p.

Thesis.

A method to determine the K-Ar of iron meteorites is described. The meteorite, after irradiation in a reactor, is subjected to HNO_3 dissolution. Using this method the potassium-argon ages of several iron meteorites were determined. The results range from 3 billion years to 15.6 billion years. The K-Ar ages determined for the meteorite Weekeroo Station were found to disagree with the Sr-Rb age of the silicate inclusions in this meteorite. The spatial distribution of K in several iron meteorites as well as its mobility under leaching conditions were studied. The results indicate K is highly concentrated in grain boundaries and inclusions. Distilled water can remove as much as 80% of the K in a specimen in 4.5 hr. Based upon data obtained in this work and previous results of other research teams a theory to account for the distribution and mobility of K in iron meteorites is presented. The conclusion of this theory is that the K-Ar ages of Fe meteorites are anomalously high. Weathering and handling of the meteorite results in preferential K loss and hence high ages. (Disser. Abstr.)

Meteorology

Refer also to abstracts 4388, 6194, and 6212.

4277 (BNL-11889) A SUMMARY OF RECENT TURBULENCE MEASUREMENTS AT BROOKHAVEN NATIONAL LABORATORY. Frizzola, J. A.; Singer, I. A.; Busch, N. E. (Brookhaven National Lab., Upton, N. Y.). Aug. 29, 1967. 21p. (CONF-670931-16). Dep. CFSTI.

From USAEC Meteorological Information Meeting, Chalk River, Ontario, Canada.

A recent analysis of mean gradient and spectral measurements at Brookhaven is reviewed. Estimates of the stress derived from mean wind profiles compare favorably with the measured quantity $-\overline{u'w'}$. However, some of the assumptions used, particularly the constancy of the stress with height at the Brookhaven site are discussed. Spectral data are presented which indicates the vertical velocity component obeys similarity theory and those spectra agree with some recent suggestions for the shape of the w spectra. The longitudinal and lateral components, u and v, also obey the similarity hypothesis but over a smaller frequency range than the w component. The v component also appears to be more influenced by thermal stratification than the other two components. The ratio of the vertical velocity variance to the stress fits into recent suggestions concerning the shape of the spectra. (auth)

4278 (EUR-3569i) STATISTICA PLURIENNALE DELLE OSSERVAZIONI METEOROLOGICHE AD ISPRA (1959-1966). (Multiannual Statistics of the Meteorological Observations at Ispra (1959-1966)). Bollini, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). June 23, 1967. 95p. (In Italian). Dep.

The mean and extreme values, made over a period of eight years, are combined into 27 tables and 21 graphs for temperature, humidity, sunshine and solar radiation, precipitation, pressure, wind and other observations. Detailed safety analyses are reported on the monographs. (auth)

4279 (NRL-F-25) ENVIRONMENTAL RADIOACTIVITY IN NEW ZEALAND AND RESULTS OF EXTENDED MONITORING OF FALLOUT FROM FRENCH NUCLEAR TESTS IN THE PACIFIC. Quarterly Report, April-June 1967. (National Radiation Lab., Christchurch (New Zealand)). 30p. Dep.

The results of routine monitoring of fallout are reported. The

results of extended monitoring of fallout from the French nuclear tests in the Pacific are given. A distinction is made between the levels of radioactivity due to long-lived radionuclides and short-lived radionuclides from the recent nuclear tests. The measurement of Sr–89 in routine rain and milk samples has been continued. These measurements are part of the extended monitoring program and comparisons are made with Sr–90 levels. (J.C.W.)

4280 CALCULATION OF NEUTRON, PRIMARY, AND SECONDARY GAMMA FLUX AT AN AIR-GROUND INTERFACE. Mittelman, Phillip S.; Guber, Walter; Kalos, Malvin (Mathematical Applications Group, Inc., White Plains, N. Y.). Trans. Amer. Nucl. Soc., 10: 730(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4281 NEUTRON TRANSPORT IN THE ATMOSPHERE. Straker, E. A.; Rodgers, R. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 730-1(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4282 ENERGY AND ANGULAR DEPENDENCE OF AIR-SCATTERED GAMMA-RAY DISTRIBUTION FUNCTIONS. Michael, J. A.; Lamonds, H. A. (Edgerton, Germeshausen and Grier, Goleta, Calif.). Trans. Amer. Nucl. Soc., 10: 731-2 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4283 STUDY OF THE ^{109}Cd FALLOUT IN CERTAIN POINTS OF THE SOVIET UNION DURING THE 1964 TO 1966 PERIOD. Fedorov, G. A.; Konstantinov, I. E.; Skotnikova, O. G.; Malakhov, S. G. At. Energ. (USSR), 23: 253-5(1967). (In Russian).

High-altitude nuclear explosions may be followed by using radioactive fallout as the tracer. In earlier studies, ^{102}Rh and ^{238}Pu were used as tracer elements; additional information was obtained by examining the fallout of ^{109}Cd in three areas of the Soviet Union during the period from 1964 to 1966. The deposits were collected in stainless-steel containers, using a cadmium acetate solution as the carrier; the solution was evaporated to dryness after exposure, in order to concentrate the activity; the cadmium was determined gravimetrically. The activity of the samples, measured by means of a γ spectrometer in 2π geometry, was found to be about 10^{-12} Ci. The data from the Transcaucasian and Muscovite regions indicated that the fallout level was below 0.03 mCi/km^2 month, agreeing in first approximation with the corresponding British and U. S. data. Further work is in progress both on collection of data and improvement of the measurement method. (TTT)

4284 STUDIES OF FALLOUT PARTICLES. VIII. Mamuro, Tetsuo; Matsunami, Tadao; Fujita, Akira (Radiation Center of Osaka Prefecture). Nippon Genshiryoku Gakkaishi, 9: 646-55(Nov. 1967). (In Japanese).

Radionuclide fractionation appearing in individual highly radioactive fallout particles from the third Chinese nuclear explosion on May 9, 1966, has been investigated by γ-ray spectrometry. The activities of the 10 nuclides, ^{95}Zr, ^{97}Zr, ^{99}Mo, ^{140}Ba, ^{141}Ce, ^{143}Ce, ^{144}Ce, ^{147}Nd, ^{237}U and ^{239}Np, were determined, and the initial atom numbers of these nuclides contained in each sample were calculated. The fractionation factor defined with respect to ^{95}Zn was calculated in order to express the degree of fractionation. The experimental results obtained are discussed in respect of the following: relation between initial atom number and particle volume; relations found among the fractionation factors; fractionation in relation to decay chains; estimation of the time interval elapsed between the detonation and the formation of particles; and dependence of the radiochemical composition on the chemical composition of the matrix materials. (auth)

4285 INFLUENCE OF THE VARIATIONS IN THE EXHALATION OF RADON AND THORON ON THE CONCENTRATION CHANGES OF THESE EMANATIONS AND OF THEIR DECAY PRODUCTS IN THE ATMOSPHERE. Malakhov, S. G.; Bakulin, V. N. (Inst. of Applied Geophysics, Moscow. Kirovograd Pedagogical Inst., USSR). Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana, 3: 773-9(July 1967). (In Russian).

Earlier studies on the radon and thoron concentration near the ground and the vertical distribution of these elements in the troposphere were based on stationary conditions and the results are not suited to evaluate the effect of nonstationary exhalation. Therefore, it was attempted to determine the effect of variations of emanations as a function of time on concentration changes in the atmosphere. The diffusion equation was solved, using the cosine of the daily variations of the exhalation as the boundary condition. The new solution revealed a strong perturbation in the radioactive equilibrium between radon and its decay products in the layer near the ground. This disturbance is not due to variations in the exhalation but to the flux of the short-lived decay products of the emanation near the surface. At a height of 1 m, the concentration ratio Rn/RaB at $k = 1$ m^2/sec varies between the limits of 7 ± 0.4 and at $k = 0.1$ m^2/sec between 2.5 ± 0.3, whereby k designates the vertical turbulent diffusion coefficient. The daily changes in the thoron exhalation are responsible for the not negligible variations in the ThB concentration in the layer near the surface of the ground. (TTT)

4286 INTERHEMISPHERIC TRANSFER OF DEBRIS FROM NUCLEAR EXPLOSIONS USING A SIMPLE ATMOSPHERIC MODEL. Peirson, D. H.; Cambray, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 216: 755-8(Nov. 25, 1967).

Using a simple atmospheric model, expressions for the reservoirs of fission products in the atmosphere from the 1961 to 62 nuclear explosions are found. Estimates of the rate of interhemispheric transfer and the ratio of northern and southern reservoirs are computed from observed values of the fission products. (auth)

4287 CORRELATIONS BETWEEN THE VERTICAL THERMAL GRADIENTS AND THE SOLAR RADIATION FOR THE CONTROL OF THE ATMOSPHERIC POLLUTION AT ISPRA. Gandino, C. (CCR-EURATOM, Ispra, Italy). Ing. Nucl., 7: No. 3-4-5-6, 1-6(May-Dec. 1966). (In Italian).

The favorable climate at Ispra in respect to sunshine can be concluded from comparison with other stations. The vertical thermal gradients, measured for the radioactive air pollution control with the meteorological tower of Ispra, are compared with the hourly solar radiation. Also two correlations between Pasquill's categories and hourly solar radiation are made. (auth)

4288 UEBERWACHUNG DER RADIOAKTIVITAET IN ABWASSER UND ABLUFT. 2., ERGAENZTE AUFLAGE. (Monitoring the Radioactivity in Waste Water and Exhaust Air. 2nd Supplementary Edition). Kiefer, Hans; Maushart, Ruprecht. Stuttgart, B. G. Teubner, 1967. 120p.

The principal methods and devices developed in recent years for monitoring the radioactivity in waste water and exhaust air are reviewed. The latest definition of permissible concentrations of radioactive materials in water and air are tabulated. The detectors and associated electronics of the principal devices for radioactivity measurement are described. The basic methods used for the measurement of activity in water and air are discussed. The application of radioactivity measurements to various fields is illustrated. These include U production and processing, fuel element separation, nuclear reactors, fuel element processing, scintillator separation, and enrichment of fuel elements. Possible further developments of instruments and methods are indicated. (J.S.R.)

Mineralogy and Exploration

Refer also to abstracts 4297 and 4303.

4289 (RME–146) ESTIMATION OF URANIUM ORE RESERVES BY STATISTICAL METHODS AND A DIGITAL COMPUTER. Meehan, Robert J.; Grundy, W. D. (Grand Junction Office (AEC), Colo. Production Evaluation Div.). Feb. 1963. 88p. Dep. CFSTI.

Sample assay values from sandstone-type uranium deposits in the western United States display a positively skewed unimodal frequency distribution. A theoretical mathematical model, the lognormal frequency distribution, seems to describe satisfactorily the shape of uranium assay value frequencies. Statistical methods developed for the South African gold fields and based on such a frequency distribution can be used for reliable estimation of uranium reserves. The ORSAC2 program is written in FORTRAN for an IBM 7090 digital computer to interpret, modify, arrange and categorize large amounts of gamma-ray drill-hole and/or channel-type sample data. The computer can also calculate arithmetic and logarithmic statistical estimators, chi-square test of goodness of fit and, based on the lognormal frequency distribution, the fractional tons and average grade on material above cutoffs 0.01 to 0.60 percent U_3O_8, and error limits at a 90-percent confidence limit for each cutoff. (auth)

4290 MINOR ELEMENTS OF THE NANBU KOTAI OF NAKATSUGO DEPOSITS, NINGYO TOGE URANIUM MINE. Watanabe, Koji (Okayama Univ., Japan). Okayama Daigaku Onsen Kenkyusho Hokoku, No. 36, 23-30(Oct. 1967). (In Japanese).

The Nakatsugo Deposits, which are the main deposits of Ningyo Toge mine in the northern part of Okayama Prefecture, consist of two main ore bodies, Nanbu Kotai (southern ore body) and Hon Kotai (main ore body). Nanbu Kotai is occupied mostly by the un-

oxidized zone and high grade ores containing ningyoite are widely found in the basal conglomerates. Minor elements in the common rocks, including basal granites, conglomerates, sandstones, dikes and shales, as well as in the uraniferous ores were determined quantitatively by fluorescent x-ray spectrometric analysis (for U, Zr, Y, Sr, As and Fe) and spectrophotometric analysis (for Ni and Co). As the result, it was found that the uraniferous ores are characterized by extremely high contents of Zr, Y, Sr and As, showing a positive and linear correlation with the U contents. The As was confirmed to be concentrated in the pyrite, usually associated with the uraniferous ores. Elements such as Ni and Co are slightly concentrated both in the uraniferous ores and andesite dikes, indicating some genetic relation among them. However, it does not appear reasonable to draw a definite conclusion concerning the origin of uranium deposits from the relations. (NSA of Japan)

4291 NEW METHOD SUGGESTED FOR LEACHING URANIUM ORE IN PLACE. Eng. Mining J., 168: No. 5, 106-7(May 1967).

A method of solution mining of underground uranium ores using a cluster of injection, recovery and monitor wells is described. Pattern of wells is determined by permeability, porosity and water bearing characteristics of the deposit. Cold acid solution, HNO_3, containing an oxidant, sodium chlorate and flocculant, is introduced into the ore zone through injection wells. Controlled pressure gradient is maintained between injection wells and recovery well. Pumping from recovery well is at a rate equal to the combined inflow volume of injection wells. Uranium is recovered from pregnant solution pumped to surface by direct precipitation or by selective ion exchange into an organic solvent with subsequent removal from organic phase of stripping agent. Average daily production on the orebody is 500 lb U_3O_8/day and tracer recovery is 90%, showing close control of the leach solution. (Disser. Abstr.)

4292 FLOTATION OF SOME AUSTRALIAN URANIUM ORES. Trahar, W. J. Australas. Inst. Mining Met. Proc., No. 221, 1-9(Mar. 1967).

The flotation behavior of some Australian uranium ores was investigated. Although uraninite and pitchblende float readily with fatty acids, selective concentration to produce an economically discardable tailing has not yet been achieved. This is attributed to the presence in the ores of a quantity of uranium mineral in finely dispersed form which is very difficult to liberate. For some of the ores, the proportion of this material decreases with increase in head assay. Flotation may be a useful concentrating method for some Australian ores if uranium oxide is to be sold in a free competitive market. (Disser. Abstr.)

4293 GEOCHEMICAL SIGNIFICANCE OF ORGANIC COMPOUNDS IN THE INCORPORATION OF URANIUM-CONTAINING MINERALS. Kranz, R. (Kernforschungsanlage, Juelich, Ger.). Naturwissenschaften, 54: 469(Sept. 1967). (In German).

Radiochemical and uranium and thorium analyses show a direct quantitative relation between the occurrence of organic compounds (especially amino compounds) and the uranium and thorium content of the mineral. Amino acids were analytically separated from fluorspar and granites with high uranium contents, and determined by paper chromatography. The presence of amino acids in uranium minerals can be clearly traced at the present. In inactive minerals, no high molecular compounds are found. A geochemical material transfer in the upper earth crust under the effect of organic materials can not be excluded. (J.S.R.)

Oceanography

4294 ^{226}Ra AND ^{222}Rn: CONCENTRATION IN ATLANTIC AND PACIFIC OCEANS. Broecker, Wallace S.; Li, Yuan Hui; Cromwell, John (Columbia Univ., New York). Contracts AT(30-1)-2493; AT(30-1)-2663. Science, 158: 1307-10(Dec. 8, 1967).

Measurements of radon-222 in seawater suggest the following. The radium-226 content of surface water in both the Atlantic and Pacific oceans is uniformly close to about 4×10^{-14} g/l. The deep Pacific has a concentration of radium-226 that is four times higher and the deep Atlantic a concentration twice as high as that of the surface. These distribution profiles can be explained by the same particle-settling rate for radium-226 from surface to depth for the oceans and by a threefold longer residence time of water in the deep Pacific than in the deep Atlantic. The vertical distribution of the deficiency of radon-222 in the surface water of the northwest Pacific Ocean suggests a coefficient of vertical eddy diffusion as high as 120 cm^2/sec and a gas-exchange rate for carbon dioxide in surface water between 14 and 60 moles m^2/yr. Vertical profiles of the excess of radon-222 in near-bottom water of the South Atlantic give coefficients of vertical eddy diffusion ranging from 1.5 to more than 50 cm^2/sec. (auth)

Seismology

Refer to abstract 4300.

ENGINEERING

Nuclear Explosions

Refer also to abstracts 4393 and 6244.

4295 (ORNL-TM-2062) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE): PROGRESS REPORT FOR JULY 1 TO SEPTEMBER 30, 1967. Arnold, W. D.; Blake, C. A. Jr.; Crouse, D. J. (comps.) (Oak Ridge National Lab., Tenn.). Nov. 17, 1967. Contract W-7405-eng-26. 20p. Dep. CFSTI.

Ruthenium was efficiently removed from $CuSO_4$-H_2SO_4 electrolyte solutions by oxidation at 90°C with ozonized air or oxygen. The oxidized ruthenium was removed from the gas stream on activated carbon, which had a saturation loading capacity of more than 2 millicuries of ^{106}Ru per gram. In the distillation of shale oil which had been contaminated with radionuclides from test shot debris, the radionuclides remained in the higher boiling fractions, principally the residuum. A major fraction of the radioactive material was present in the oil as finely divided solids rather than in solution. A retorting test with Green River oil shale which had been given prolonged exposure to tritiated water vapor at about 90°C produced tritium-contaminated oil. After washing with water, the oil contained 30 mc ^3H/gallon. The oil will be fractionally distilled to determine the tritium distribution in the distillation products. Direct analysis of shale oil for tritium by liquid scintillation counting was not possible because the oil contained both quenching material and phosphorescent material. Fairly consistent results were obtained by burning samples of the shale oil in a tube furnace and measuring the tritium concentration in the water condensed from the off-gas. (auth)

4296 (PNE-516) POSTSHOT GEOLOGIC AND ENGINEERING PROPERTIES INVESTIGATIONS. Project PRE-SCHOONER II. Frandsen, Alton D. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). Sept. 1967. Contract W-7405-eng-48. 68p. Dep. CFSTI.

The Pre-Schooner II Event was a chemical explosive single-charge cratering experiment in hard, dry rock. The detonation was centered 71 ft below the ground surface and consisted of approximately 85.5 tons of nitromethane. The explosion produced a crater with an apparent radius of 95.2 ft and an apparent crater depth of 60.7 ft. Postshot explorations of the crater consisted of excavating three radial trenches through the lip material and then extending two of the trenches into the fallback within the crater. Both bulk densities and block-size distribution of the ejecta and fallback were obtained. Bulk densities averaged 103.8 pcf except for an anomolous value of 93.1 pcf in one trench. Block sizes varied from fines of clay size to blocks greater than 6 ft in diameter. The true crater radius and the lip upthrust were measured at the three trenches and averaged 100 ft and 11 ft, respectively. The crater slope angles measured before, during, and after completion of the fallback excavation averaged 37, 42, and 38 degrees, respectively. (auth)

4297 (PNE-1300) SLOOP. Zimmer, Peter F.; Lekas, M. A. (comps. and eds.) (Kennecott Copper Corp., Salt Lake City, Utah. Bureau of Mines, Washington, D. C. California Univ., Livermore. Lawrence Radiation Lab.). June 1, 1967. 44p. Dep. CFSTI.

The feasibility of fracturing low-grade copper deposits with nuclear explosives in preparation for extracting copper by in-place leaching methods is investigated. The study is part of the Plowshare program and includes detailed investigations of both the explosive fracturing and the leaching aspects, and includes the design of an experiment (Project Sloop) to field test the application. A low-grade copper deposit was investigated as a possible site to test the concepts. The results indicate that a deeply buried nuclear explosive can adequately fracture a portion of the deposit for the test. Based on previous test work, the ore mineralization should respond favorably to leaching recovery methods. The study also concludes that an effective experiment can be designed which would satisfy both the technical objectives and meet all safety requirements. Possible radioactive contamination of the copper is considered to be a manageable problem both for the experimental and for general application. Radioactivity in the leaching solutions should be at low enough levels that shielding should not be required for personnel protection. (J.C.W.)

4298 (UCRL-13322) FIELD MEASUREMENTS OF GROUND MOTION, DUMONT AND VULCAN. Final Report. (Northrop Corporate Labs., Hawthorne, Calif.). Oct. 1967. Subcontract 326. 61p. Dep. CFSTI.

Earth motion measurements were made as part of two events at Nevada Test Site. Measurement made on DUMONT were obtained from 3 accelerometers and 9 velocity gages, all of which were mounted in surface canisters at various distances from surface ground zero. Measurements made on VULCAN were obtained from 4 surface velocity gages, 5 surface accelerometers, 7 subsurface velocity gages, 14 subsurface accelerometers, and 1 velocity gage on the top of the casing in the emplacement hole. On DUMONT, engine generator failure occurred at the time of arrival of the ground shock wave at the instrumentation trailer. All data subsequent to t = +900 msec were lost. Data were acquired on 33 of 34 ground-motion measurement channels on VULCAN. Zero-time, data, in general, appear to be interpretable. Subsidence data appear to be of three qualities: one-third is clear and readily interpretable; one-third has noise and erratic signals but careful data processing can retrieve useful information; one-third has extensive noise and erratic signals and is of questionable usefulness. (auth)

4299 (UCRL-Trans-10145) CONNECTION BETWEEN THE RADIUS AND THE DURATION OF EXISTENCE OF THE CAVITIES CAUSED BY UNDERGROUND NUCLEAR EXPLOSIONS. Duclaux, F.; Derlich, S.; Faure, J.; Ferrieus, H.; Perrier, M. Translated by F. D. Jones for Univ. of California, Lawrence Radiation Lab., Livermore, from Compt. Rend., Ser. A and B, 264: 496-7(1967). 6p. Dep. CFSTI. JCL $1,10 fs, $0,80 mf.

An explanation of the linear relationship between the radius of the cavity formed by an underground nuclear explosion and the time elapsing from the explosion to the collapse of the roof of this cavity is presented. The law is based on experiments carried out in granite massif. Deviation between the low and representative points is slight. The relative deviation is not more than 6%. Accuracy obtained by drilling the cavity and making direct measurements is of the same order. (F.S.)

4300 REVIEW OF THE SALMON EXPERIMENT: A NUCLEAR EXPLOSION IN SALT. Rawson, D. E.; Taylor, R. W.; Springer, D. L. (Univ. of California, Livermore). Contract W-7405-eng-48. Naturwissenschaften, 54: 525-31(Oct. 1967). (UCRL-70260).

The Salmon experiment was conducted to investigate the generation and propagation of seismic waves from an explosion in a salt dome. The effect on the surrounding salt including inelastic response near the explosion such as vaporization, melting, crushing, cracking, and plastic flow and the more distant seismic or elastic responses are summarized. The inside of the cavity was studied by television and photographic cameras. A 0.35 kT nuclear device was detonated in the cavity to study decoupling. (F.S.)

4301 ATOM AIMS FOR ROLE AS PROSPECTOR. Bus. Week, No. 1946, 83-6(Dec. 17, 1966).

The use of underground nuclear explosions to unlock gas, mineral, and oil reserves is examined from a commercial viewpoint stressing the companies interested in the immediate application, current AEC developments, the costs involved, and feasibility and safety considerations. (L.C.L.)

Facilities and Equipment

Refer also to abstracts 4303, 4371, 5288, 5289, 5292, 6222, 6225, and 6226.

4302 (CEA-R-3259) SEPARATION DE L'IODE A PARTIR D'UN BARREAU D'URANIUM. (Separation of Iodine From an Uranium Slug). Beraha, Robert; Berlin, Marguerite (Commissariat a l'Energie Atomique, Chuscian (France). Centre d'Etudes Nucleaires). July 1967. 18p. (In French). Dep.

The separation and determination of fission-product iodine from uranium fuel samples are studied. The steps of the process shown are the dissolution of the slugs, distillation and iodine determination. A simple apparatus for the dissolution and distillation is described. Emphasis is placed on the knowledge of the whole operation yield and its reproducibility. (auth)

4303 (EUR-3568f) REPERTOIRE DES INSTALLATIONS NUCLEAIRES DE LA COMMUNAUTE EUROPEENNE DE L'ENERGIE ATOMIQUE. Quatrieme Edition. (Nuclear Installations in the Countries of the European Atomic Energy Community. Fourth Edition). (European Atomic Energy Community). Sept. 1967. 120p. (In French). Dep.

A listing of all the nuclear installations in the countries of the European Atomic Energy Community is presented. Included are those nuclear installations which already exist, those under construction, those not yet under construction but whose construction

has been decided, and installations which are being planned. A short description is given of the main characteristics of each installation, and the more important enterprises which are known to have participated in the building of these installations are identified. (auth)

4304 (EUR-3612f) INSTALLATION D'EXTRACTION PAR SOLVANT A UN SEUL ETAGE (PROJET GLAUCIDIE). (Plant for Single-Tier Extraction by Solvent (Project GLAUCIDIE)). Fradin, J.; Gaudichard, C. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 85p. (In French). Dep.

A plant was constructed for the study of solvent extraction of strontium-90 and rare earths from cesium-137-free fission-product solutions. The plant is simple and versatile making it possible to study new extractants and to carry out operations of liquid-liquid extraction relating to highly radioactive solutions. The plant, its chemical apparatus and the control, measurement, regulation and monitoring equipment are described. (auth)

4305 (INR-823/XVIII/PP) ZALACZANIE GENERATOROW UDAROW PRADOWYCH ISKIERNIKAMI CZTEROELEKTRODOWYMI. (Switching of High Current Impulse Generators with Four Electrode Spark Gaps). Jerzykiewicz, Andrzej; Sadowski, Marek (Institute of Nuclear Research, Warsaw (Poland)). 1967. 41p. (In Polish). Dep.

Technical requirements of spark gaps at parallel action are discussed and triggering devices for four electrode spark gaps are described. Operating characteristics of time delay to breakdown and jitter time versus applied dc voltage and triggering voltage are given. The results of research on parallel action of spark gaps in the six-section impulse current generator are described. (auth)

4306 (SCL-DR-67-49) DEVELOPMENT OF A TECHNIQUE FOR TESTING WITH HEAVY GASES IN EXPLOSIVE-DRIVEN SHOCK TUBES. Emery, A. F.; Ashurst, W. T. (Sandia Corp., Livermore, Calif.). Nov. 1967. Contract AT(29-1)-789. 58p. Dep. CFSTI.

A chronological review of the development of the Thunderpipe technique for shock tube testing with heavy gases is developed. The feasibility of testing with octofluorocyclobutane (C_4F_8) and sulfur hexafluoride (SF_6) was indicated by an initial series of tests in a small laboratory shock tube. Subsequent production tests in larger shock tubes, however, revealed the presence of random pressure variations in the preferred gas, C_4F_8. A further investigation of the properties of C_4F_8 was therefore carried out. Examination of shock front photographs and analytical studies showed that the irregularities were caused by decomposition of the gas behind the shock. The use of a nitrogen buffer between the explosive and the C_4F_8 was found to alleviate the problem only slightly. Photographs of shock fronts in SF_6 showed no decomposition, and although pressure irregularities in production testing were observed, their distribution was not random. Analytical studies using numerical computations have shown these irregularities to be the result of oscillating flow fields formed by asymmetrical charge distributions and perturbations caused by an impedance mismatch at the contact surface. (auth)

4307 (SCL-DR-67-115) MOMENTUM APPROACH FOR CALCULATING THE ATTENUATION OF PRESSURE PULSES IN DISTENDED MATERIALS. Anderson, P. D. (Sandia Corp., Livermore, Calif.). Oct. 1967. Contract AT(29-1)-1789. 12p. Dep. CFSTI.

A simple method, based on momentum conservation, is developed for predicting the attenuation of thin pressure pulses in distended materials. (auth)

4308 (TID-24029) DEVELOPMENT OF FAST NEUTRON ACTIVATION ANALYSIS FOR LIQUID LOOP SYSTEMS. Wood, D. E. (Kaman Nuclear, Colorado Springs, Colo.). July 1967. Contract AT(29-2)-2115. 31p. (KN-67-458(R)). Dep. CFSTI.

A liquid loop activation analysis system has been constructed and tested for use in developing on-line analytical capabilities for future industrial installations. The system can simulate process streams with variable flow rates and times of decay and counting. Several counting channels are provided with variable windows to allow selection of various gamma rays for analysis. Applications to several industrial problems have been tested and shown promising for continued work and possible system installation. (auth)

4309 (TID-24102) THE NUCLEAR INDUSTRY, 1967. (Division of Industrial Participation (AEC), Washington, D. C.). 184p. (CONF-671115-1). Dep. GPO $1.00.

From Atomic Industrial Forum's Annual Conference, Chicago, Ill.

The peaceful application of nuclear energy that has the most impact on the U. S. economy is that of nuclear reactors to produce steam for generation of electric power. The volume of orders for nuclear-electric generating units for 1966 is compared with that for nine months of 1967. Other applications of nuclear energy are associated with desalting water, providing electric power for space and the ocean bottom, commercial explosives, preserving food, and producing new wood–plastic products. (J.C.W.)

4310 (TID-24104) PRELIMINARY INVESTIGATION OF HOT FILM ANEMOMETER IN TWO-PHASE FLOW. Status Report. Jones, O. C. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 1966. 19p. (TO-EE-540). Dep. CFSTI.

A hot film anemometer probe is described which is capable of being used with suitable recording and analyzing techniques in the determination of pointwise void fraction and fluid velocities, as well as temperatures in two-phase flow. The anemometer is not restricted for use in only a small range of flows but is suitable for use in all flow regimes. It is felt that perfection of the use of this probe would yield an invaluable aid to the thermal analyst by providing more detailed information about the phase distribution, velocities, and movement than is obtainable by any other means. (auth)

4311 (UCRL-17621) PULSED POWER SUPPLY FOR ELECTROLUMINESCENT FIDUCIAL DISPLAY SYSTEM. Kerns, Cordon R. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 20, 1967. Contract W-7405-eng-48. 12p. (CONF-671026-8). Dep. CFSTI.

From 14th Nuclear Science Symposium, Los Angeles, Calif.

A pulsed power supply has been developed which is suitable for powering electroluminescent lamps at frequencies up to 5 kHz. A distribution system for driving 90 or more lamps simultaneously and a programmed data-lamp array utilizing the power supply are also described. (auth)

4312 TRANSURANIUM-ELEMENT PROCESSING. Ferguson, D. E. (Oak Ridge National Lab., Tenn.). Isotop. Radiat. Technol., 4: 321-4(Summer 1967).

The chemical processing scheme and the design of the facility for processing the transuranium elements at Oak Ridge National Laboratory are described. (auth)

4313 POTENTIAL MARKETS FOR RADIOISOTOPE-BASED ANALYTICAL EQUIPMENT. Gerrard, Martha. Isotop. Radiat. Technol., 4: 366-9(Summer 1967).

A survey of French metallurgical, chemical, and mining industries, sponsored by the Commissariat a l'Energie Atomique, indicated that analytical techniques based on radioisotope generated x ray fluorescence in particular but also on gamma radiation absorption and beta radiation backscattering could, in many cases, profitably replace or complement standard physical and chemical methods of analysis. Equipment for continuous analysis and process control is of interest, and the time appears ripe for rapid development of industrial radioisotope based equipment. (auth)

4314 DISPENSING AND SAMPLING SODIUM FOR THE LMFBR CLADDING PROJECT. Murbach, E. W.; Bodine, J. E. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 493(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4315 NUCLEAR LABORATORY TECHNIQUES FOR MATERIALS RESEARCH. Rosenbaum, H. S. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 10: 502(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4316 CONTROLLED TEMPERATURE-PRESSURE IRRADIATION CAPSULES. Hann, C. R.; Marshall, R. K.; Pilger, J. P.; Leggett, R. D. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 502-3(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4317 PYROLYTIC-CARBON COATING IN AN ENGINEERING-SCALE SYSTEM. Pratt, R. B.; Sease, J. D.; Lotts, A. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 510-11(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4318 PROGRAMMING INNOVATIONS AND THEIR EFFECT ON ENGINEERING APPLICATIONS. Rochester, Nathaniel (IBM Federal Systems Div., Cambridge, Mass.). Trans. Amer. Nucl. Soc., 10: 521(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4319 SUPPORT EQUIPMENT FOR REMOTE REASSEMBLY OF A NUCLEAR ROCKET ENGINE. Yee, H. A.; Swain, R. K. (Aerojet General Corp., Sacramento, Calif.). Trans. Amer. Nucl. Soc., 10: 677(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4320 THE ALPHA–BETA–GAMMA LABORATORY OF THE EUROPEAN INSTITUTE FOR TRANSURANIUM ELEMENTS. Samsel, Gerard (EURATOM, Karlsruhe, Ger.). Trans. Amer. Nucl. Soc., 10: 685-6(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4321 PREPARING FOR DISASSEMBLY OPERATIONS OF NUCLEAR ENGINE HARDWARE. Schaffstall, R. E.; White, L. E. (Aerojet General Corp., Sacramento, Calif.). Trans. Amer. Nucl. Soc., 10: 676(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4322 THE RAILROAD TRANSPORT SYSTEM TO BE USED FOR NUCLEAR ROCKET ENGINE TRANSPORTATION AND INSTALLATION INTO TEST STAND. McClurkin, J. L.; Swain, R. K. (Aerojet General Corp., Sacramento, Calif.). Trans. Amer. Nucl. Soc., 10: 675(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4323 OPERATIONAL DEVELOPMENT OF THE RAILROAD TRANSPORT SYSTEM. Krelovich, L.; White, L. E. (Aerojet General Corp., Sacramento, Calif.). Trans. Amer. Nucl. Soc., 10: 675-6(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4324 PROBLEMS AND SUCCESSES IN THE FIRST MAJOR MAINTENANCE PERFORMED IN THE TRANSURANIUM PROCESSING PLANT. Matherne, J. L.; Collins, E. D.; Evans, W. W. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 665(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4325 PROPAGATION OF SHOCK WAVES THROUGH TWO-PHASE, TWO-COMPONENT MEDIA. Hamilton, L. J.; Nyer, R.; Schrock, V. E. (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc., 10: 660(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4326 DEVICE FOR TRANSFER AND DILUTION OF RADIOACTIVE GASES. Elfers, Lawrence A.; Herman, Mark (National Center for Air Pollution Control, Cincinnati). Anal. Chem., 39: 1909-10(Dec. 1967).

A device is described which is used in the transfer or dilution of radioactive gases employed as tracers in air pollution studies. The device, in one operation, breaks the glass ampoule, transfers the tracer gas into a steel cylinder and dilutes the gas under high pressure with inert gas. It consists of stainless steel pipe sections and fittings joined so as to form a barrel for the guidance of a projectile and a larger compartment for the glass ampoule. The projectile is propelled by the pressure of the diluent gas. One-way check values withstand pressures higher than the maximum diluent gas pressure. Experience in the transfer of $^{35}SO_2$ gas has proved the safety of the device. (F.S.)

4327 BEHAVIOR OF A PRESTRESSED CONCRETE VESSEL SUBJECTED TO A HIGH TEMPERATURE GRADIENT. Dubois, Frederic (CEN de Saclay, Gif-sur-Yvette, France); Bonvalet, Charles; Dawance, Guy; Marechal, Jean-Claude. Nucl. Eng. Design, 6: 273-300(1967). (In French).

In studying the behavior of a prestressed concrete pressure vessel subjected to a high temperature gradient, a knowledge of the mechanical and thermal properties of the concrete based on silicious limestone granulate, kept at 20°C in a controlled-humidity cell. Measurements of the mechanical mean strengths carried out on the concrete at 450 days gave results of the order of 37 kg/cm^2 for tension and 380 kg/cm^2 for compression. Resistance to compression as a function of temperature was measured on prismatic sample 7 × 7 × 28 cm in size and 28 days old. This concrete was also subjected to expansion, creep, and thermal conductivity measurements. These preliminary studies were followed by the use of a loading machine by means of which concrete intended for the construction of pressure vessels can be examined from the viewpoint of resistance to thermal cycling. This machine is essentially a device for loading at constant moment, a beam resting on two simple supports. The beam, of constant cross section, is subjected to a temperature difference between its hot and cold faces. It is thus possible to determine the mean value of the product $E_m\alpha$, which can be called thermal rigidity modulus and will be expressed in kg/cm^2°C^{-1}. This value is involved directly in experiments on thermal stresses provided by thermoelasticity. The study was then continued on a $^1/_{10}$th model of a cylindrical prestressed concrete pressure vessel with no base or lateral opening. Some theoretical considerations on the conditions of similarity between the model and the actual product are provided under stationary and transitory conditions, with regard to stresses, strains, and the water and steam migration speed. The model was prestressed by 39 vertical and 43 horizontal cables (Freyssinet system). The inner face of the model was heated electrically, and the outer face of the concrete was cooled by passage of an air current at a velocity of about 10 m/sec. The variation of the temperature gradient in the thickness of the cylinder was followed during the various heating cycles. From the results it was possible to deduce an overall transfer coefficient which takes into account the heat and water transfer, and which represents very approximately the thermal conductivity coefficient variation as a function of temperature. The overall deformations observed were compatible with thermal deformation theory; the creep of the cables reached 20 to 30% according to their position with respect to the inner surface. The dynamic elasticity modulus decreased by half but the concrete retained good mechanical characteristics. From the tests on the model it was possible to develop a method of structural analysis for concrete pressure vessels subjected to a temperature gradient. The principle of the method of analysis is proposed, but it is only applicable when the mechanical behavior of a given concrete at a given temperature is known. (auth)

4328 EXPERIENCE WITH GLOVEBOX INERT ATMOSPHERE CONTROL SYSTEM. Holcomb, William F. (Argonne National Lab., Idaho Falls, Idaho). Nucl. Eng. Design, 6: 213-16(1967).

A glovebox equipped with a recirculating inert atmosphere of high purity and used for the handling and preparation of sodium for fuel elements at the Fuel Cycle Facility for the Second Experimental Breeder Reactor is described. The argon gas purification system consists of a palladium catalyst for removing oxygen, molecular sieve dryer for removing water, and a canned blower for circulating the gas. The purification system serves a 250 ft^3 glovebox complex and with continuous operation can maintain an atmosphere with oxygen impurities of 2 ppM and water impurities of 6 ppM at an inleakage rate of 0.002 ft^3/hr of air while operating the glovebox complex at a negative pressure of 1 in. of water. (auth)

4329 NEW LABORATORY AIR SAMPLER WITH LOW OPERATIONAL NOISE. Miwa, Hirohide; Yamamoto, Yuzo (Kobe Ind. Corp., Japan). Hoken Butsuri, 1: No. 2, 46-8(Dec. 1966). (In Japanese).

A laboratory air sampler, having high mobility and reduced operational noise, was developed. It is used to collect the airborne particles in such areas that are located away from stationary monitors or are contaminated accidentally by radioactivity. Primary considerations in the design of the instrument were reduced external size, weight, and operational noise. Filter paper and active carbon cartridge filters for the filtration of iodine can be installed in a filter box at the top of the instrument and easily replaced. (NSA of Japan)

4330 METHOD AND DEVICE FOR ELECTRICALLY WELDING A THERMOCOUPLE SHEATH. Besse, Rene; Maurel, Jean; Ratier, Jean-Louis; Schneider, Robert (to Commissariat a l'Energie Atomique). British Patent 1,089,164. Nov. 1, 1967. Priority date Feb. 16, 1965, France.

Equipment and methods are described for electrically welding thermocouple sheaths to thermocouples. The method consists of introducing the sheath into a sleeve which is locked between two pairs of electrically conductive metal jaws connected by an insulating washer. An electric welding current is applied so that it passes through one pair of jaws to the other, through the sleeve and the sheath causing the portions of the sleeve and sheath passing through the washer to be welded together. The thermocouple is then welded to the sheath in the same manner. (F.S.)

4331 GLOVE PORT FOR DRY BOX. Becker, W. W. (to U. S. Atomic Energy Commission). U. S. Patent 3,356,254. Dec. 5, 1967.

A glove port for use in a dry box is described. The glove port consists of a pair of annularly spaced glove elements between which a pressurized gas is circulated. In the event of a leak the gas will escape thereby preventing direct communication between the inside and outside of the glove box. In addition, the presence

of the gas in or out of the glove box acts as a signal to indicate the presence of a leak. (auth)

4332 MANIPULATOR GLOVE FOR A GLOVE CABINET. (to Piercan Le Latex De France). British Patent 1,092,441. Nov. 22, 1967. Priority date Jan. 25, 1965, France.

The design of a glove for a glove box is described. The glove has a forearm portion designed to grip the operator just below the elbow and a length between the wrist and elbow which telescopes into itself when the arm is partially withdrawn from the box, thereby permitting the operator to keep his fingers in the glove fingers while moving his arm back and forth laterally in the glove box. (L.C.L.)

4333 FLUID CONTROL MEANS. Bryant, Terence Graham (to Nuclear Power Plant Co., Ltd. AEI-John Thompson Nuclear Energy Co., Ltd.). British Patent 1,092,534. Nov. 29, 1967. Filed May 6, 1964.

A method for controlling the flow of fluid through a duct, such as the flow of cooling fluid in fuel channels, is described. One or more convergent-divergent nozzles are used having a part defining a convergent passage and a part defining a divergent passage. These parts are movable relative to each other along the direction of fluid flow so that they may be moved apart to positions in which the pressure recovery property of the nozzle is destroyed, preventing an increase in the mass flow through the channel or limiting it to a prescribed value when the fuel elements are removed from the channel. (F.S.)

4334 IMPROVEMENTS IN RADIATION SHIELDS. (to General Electric Co.). British Patent 1,092,620. Nov. 29, 1967. Priority date Oct. 23, 1965, United States.

A relatively simple radiation shielding system for disconnecting service lines to radioactive devices located inside shielding cells is described. This operation is essential when it is necessary to remove the device from the cell. Complete specifications are included. (W.H.K.)

4335 REMOTE CONTROL MANIPULATOR. (to Programmed and Remote Systems Corp.). British Patent 1,092,950. Nov. 29, 1967. Priority date Apr. 28, 1964, United States.

A remote control manipulator is described where motions of a control unit moved by an operator are reproduced by a manipulator unit through electrical signals from the control unit. Specifications are presented. (W.H.K.)

4336 METHOD AND APPARATUS FOR BATCH IRRADIATION OF SUBSTANCES. (to Atomic Energy of Canada Ltd.). British Patent 1,092,768. Nov. 29, 1967. Priority date Dec. 18, 1964, Canada.

The design of a sample holder to provide uniform irradiation of the sample is presented. The sample is rotated along an axis and subsequently rotated along various axes, parallel to the first, while the irradiation source is repositioned each time. (W.H.K.)

4337 DISTILLATION PLANT. Stewart, Ronald MacPherson (to Rolls-Royce Ltd.). British Patent 1,091,616. Nov. 22, 1967. Filed June 1, 1966.

A distillation plant for producing potable water from sea water consists of at least one chamber having a reservoir adapted to receive a relatively hot liquid, a portion of which is evaporated, and a conduit, which is adapted to be supplied with relatively cool liquid and on which vapor from the liquid in the reservoir condenses. The plant includes a boiler section, a prime mover, a condenser section, and a pump. (B.L.M.)

Heat Transfer and Fluid Flow

Refer also to abstracts 4310, 4333, and 4375.

4338 (KAPL-M-6533) LION TALES: A USERS' MANUAL FOR THE LION THERMAL-STRUCTURAL EVALUATION CODE. Fischer, W. W. (Knolls Atomic Power Lab., Schenectady, N. Y.). July 31, 1967. Contract W-31-109-eng-52. 178p. Dep. CFSTI.

LION TALES presents details pertinent to the use of the LION code when applied to transient and steady state thermal-structural temperature distribution problems. The code is described briefly followed by input description for basic and optional features usage as well as for certain setup techniques. Details are given for completing each type of punchcard used. Included also are details of the code verification made by means of comparison to analytical results for a rather severe transient. (auth)

4339 (LA-3798) EFFECT OF VIBRATION ON HEAT PIPE PERFORMANCE. Deverall, J. E. (Los Alamos Scientific Lab., N. Mex.). Oct. 4, 1967. Contract W-7405-eng-36. 7p. Dep. CFSTI.

A water heat pipe was operated while being subjected to typical sinusoidal and random vibrations encountered during a missile launch to determine the effect of vibration on heat pipe performance. The results of the experiment indicate that vibration tends to improve heat pipe performance as it promotes better wetting of the wick structure by the fluid. (auth)

4340 (NYO-3679-2) HEAT TRANSFER AND HYDRAULICS. THE EFFECTS OF SUBCOOLED VOIDS. Second Quarterly Report, July-September 1967. Staub, F. W.; Walmet, G. (General Electric Co., Schenectady, N. Y. Research and Development Center). Sept. 1967. Contract AT(30-1)-3679. 41p. (EURAEC-1936; S-67-1161). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The construction, insulation, wiring, instrumentation, and pressure check-out of a low pressure test loop for the measurement of the initiation and early development of the subcooled void profile was completed. Joints with defective threads were repaired and the make-up and main pump seals were replaced. The test stand design was modified and completed except for final wiring and shielding. Check-out procedures necessitated alterations in the observation window support assembly of the test section. The electrical power supply was completed and performed satisfactorily when tested. The prediction method for the net void inception point has been extended to large aspect ratio rectangular channels with either one or both walls heated. Results of the analysis were compared with available data. A data reduction method for the evaluation of the radial from the experimental chordal void profile in circular tubes was prepared. Design of the circular test section for measuring void profiles, pressure drop and heat transfer coefficients at a reduced pressure was completed and requests for bids initiated. The General Electric test loop was modified to accommodate the desired range of test variables and to yield greater flexibility in loop operation. (F.S.)

4341 (ORNL-TM-1942) GENGTC: A ONE-DIMENSIONAL CEIR COMPUTER PROGRAM FOR CAPSULE TEMPERATURE CALCULATIONS IN CYLINDRICAL GEOMETRY. Roland, Hall C. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 19p. Dep. CFSTI.

An analysis has been made and a generalized computer program in BASIC language is presented for one dimensional radial heat transfer calculations in cylindrical geometry. Provision is made for fission heat, gamma heat, multiple solid radiation shields, liquid filled annuli and gas filled annuli. Radiation heat transfer across gas filled annuli is included. Correction is made for variation of thermal conductivities with temperature and for changes in dimensions due to thermal expansion. (auth)

4342 (PRP-67-1184) ORGANIC RANKINE CYCLE FEASIBILITY DEMONSTRATION PROGRAM. Sixth Quarterly Report, July 17-September 30, 1967. (Philco-Ford Corp., Newport Beach, Calif. Aeronutronic Div.). Oct. 16, 1967. Contract AT(04-3)-650. 31p. Dep. CFSTI.

The data are summarized for the 1000 hr recirculation boiler test of MIPB for its thermal breakdown characteristics. After 1000 hr, approximately 10% of the MIPB had been converted, mostly to other biphenyl compounds. Gas analysis and the evidence of 0.5% heavy compounds indicated the expected dehydrogenation and condensation typical of thermal degradation. No appreciable boiler fouling occurred, but the generation of 0.04 scf/day of gas was established. The presence of a leak of approximately 0.003 scf/day of inducted air was fairly well established. Highly detailed liquid and gas analyses were conducted. The plan of the next test run is described. A 5000 hr endurance test will be run for an essentially direct comparison with data on biphenyl and Dowtherm as generated by the Sundstrand Corporation. A once-through salt-bath heated boiler will be used. (auth)

4343 (PWAC-218) FUNCTION SCALES AND NOMOGRAPH FOR THE CALCULATION OF AIR PRESSURE DROP THROUGH CONSTANT-AREA HEATED PASSAGE. Kvick, Paul G. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). [nd]. Contract AT(30-1)-2789. 22p. Dep. CFSTI.

The pressure drop in a constant-area heated passage for air is approximately solved by assuming that air is a perfect gas, that the isentropic relations between static and stagnation conditions at any point of the flow are satisfied, and that the mass flow rate is constant. Under these conditions the momentum equation takes a simple form which is integrated to yield the static pressure drop when the mean value of the specific volume of the air in the passage is known. By using the geometric mean of the inlet and exit specific volumes as an estimate of the true mean, a fourth degree polynominal is obtained. The ratio of exit total pressure to inlet

total pressure may be expressed as a function of the least positive root of this equation. The function scales and nomograph are constructed to ease the task of computing the coefficients of the polynomial and the value of the total pressure ratio corresponding to its least positive root. (auth)

4344 STUDY OF INTERCHANNEL MIXING EMPLOYING ACTIVATION ANALYSIS. Biggs, W. M.; Rust, J. H. (Univ. of Virginia, Charlottesville). Trans. Amer. Nucl. Soc., 10: 655-6 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4345 FLOW PROFILE AND CROSS FLOW MEASUREMENTS BY NOISE ANALYSIS TECHNIQUES. Peikrul, P. J. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 656-7 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4346 MIXING OF A TRACE GAS IN FLOWING HELIUM. Carroll, R. M. (Oak Ridge National Lab., Tenn.); Perez, R. B.; Sisman, O. Trans. Amer. Nucl. Soc., 10: 657 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4347 ONE-COMPONENT TWO-PHASE CRITICAL FLOW AT LOW QUALITIES. Henry, Robert E. (Argonne National Lab., Ill.); Fauske, Hans K.; McComas, Stuart T. Trans. Amer. Nucl. Soc., 10: 658-9 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4348 COMPARISON OF EQUILIBRIUM AND NONEQUILIBRIUM THERMODYNAMIC MODELS IN A WATER-REACTOR PRESSURIZER. Nahavandi, Amir N. (Univ. of Vermont, Burlington); Chiabrandy, Robert E.; Amidon, John L. Trans. Amer. Nucl. Soc., 10: 659-60 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4349 EXPERIMENTAL STUDY OF MIXING BETWEEN ROD-BUNDLE FUEL-ELEMENT FLOW CHANNELS DURING BOILING. Rowe, D. S.; Angle, C. W. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 655 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4350 EVALUATION OF THE DILATATION TECHNIQUE FOR THE MEASUREMENT OF TOTAL VAPOR VOLUME IN CHANNELS UNDER STEADY STATE AND DYNAMICS CONDITIONS. Possa, G. (CISE, Milan); Schrock, V. E.; van Erp, J. B. Energ. Nucl. (Milan), 14: 621-37 (Nov. 1967).

An evaluation of the dilation technique as a means for measuring total vapor volume in heated channels, both under steady state and dynamic conditions, is given. Experimental results, obtained using as coolant a water-steam mixture at a pressure of 9 kg/cm^2 abs in a heated test-section of tubular geometry, are presented, including transfer functions in the frequency range of 0.02 to 2 cps, with test-section power and inlet enthalpy as independent variables, and total steam volume and system pressure as dependent variables. (auth)

4351 A PROCESS FOR CONTROLLING THE TEMPERATURE OF A FLUID HEATED BY HEAT EXCHANGE WITH A HEATING FLUID, FOR USE FOR EXAMPLE, IN A NUCLEAR INSTALLATION. de Livois, Guy (to Electricite de France (Service National)). British Patent 1,092,339. Nov. 22, 1967. Priority date Aug. 13, 1964, France.

A process is described for controlling the outlet temperature of a fluid heated by heat transfer from another fluid in a heat exchanger so that the difference between the outlet temperature and the inlet temperature of the heating fluid is maintained at a reference value. The rate of flow through the heat exchanger of either the heated fluid or heating fluid is controlled by means of a control signal produced by deviation from the reference value of the difference between the inlet temperature of the heating fluid and the outlet temperature of the heated fluid. (B.L.M.)

Isotope Technology

Refer also to abstracts 4325, 4367, 4370, 4391, and 6206.

4352 (BNWL-551) USER'S MANUAL FOR THE BATTELLE-NORTHWEST ISOTOPIC DATA TAPE. Reynolds, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1967. Contract AT(45-1)-1830. 41p. Dep. CFSTI.

A computer program was prepared which provides an efficient means of using a data tape to survey selected aspects of isotopes, to identify isotopes by property, and to determine chains of nuclear processes. (auth)

4353 (EUR-3627e) WEAR MEASUREMENTS BY MEANS OF γ-X-FLUORESCENCE. Kemper, A. (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Delft. Centraal Laboratorium). 1967. 43p. Dep.

The excitation of x rays by gamma radiation can be applied to wear measurements by placing a γ-source plus an x-ray detector on one side of the wearing material and an (nonradioactive) x-ray target inside or on the other side of the wearing material. The attenuation of the characteristic x rays excited in the target, can be a measure of the (varying) thickness of the wearing layer. The use of radioisotopes is restricted to the time required for the measurements, so the hazards of radiation and contamination are not present. A rubber flooring compound of 1.6 mm thickness was chosen for the evaluation of the method, since a practical performance trial with this material could be conducted under relatively simple conditions in addition to the laboratory experiments. The procedure in an actual wearing experiment is simple. Targets of silver sheet are applied at points under the flooring tiles and left in position. A measuring probe is placed on the flooring on top of the targets after certain intervals of time depending on the traffic density and the wear rate expected. Then the Ag-KX-signal is registered by single-channel counting. Wear can be assessed by comparing this signal with a calibration graph established in the laboratory. A portable probe containing an ^{241}Am source and a shielded detector part has been developed. This probe can be operated in connection with commercially available analyzing equipment. (auth)

4354 (MND-3607-80) SNAP 19 RADIOISOTOPE POWER SUPPLY: OPERATION AND FIELD MAINTENANCE. Technical Manual. (Martin-Marietta Corp., Baltimore, Md). Oct. 31, 1967. Contract AT(30-1)-3607. 287p. CFSTI.

An operating and maintenance manual, including instructions for mounting the SNAP-19 radioisotope power supply on the Nimbus B spacecraft to augment the spacecraft solar array and batteries is presented. Procedures are given in step-by-step form. Maintenance instructions are limited to isolating trouble to a major unit and replacing the unit. The manual gives a general description of the complete system, general and specific information on shipping and handling equipment for the fueled generator, shipping and handling procedures for electrically heated generators, system assembly, installation, and checkout procedures, troubleshooting and maintenance information, and sample data sheets for check-out procedures. (F.S.)

4355 (NAA-SR-12578) LARGE RADIOISOTOPE HEAT SOURCE CAPSULE (LRHSC). Quarterly Progress Report No. 1, July–September 1967. (Atomics International, Canoga Park, Calif.). Oct. 30, 1967. Contract AT(29-2)-2338. 105p. Dep. CFSTI.

Analyses have been accomplished on the shrink-fit of the capsule structural shell to the inner fuel assembly, the pressure restrictions on the helium under the Pt-10Rh clad and the pressure-electrical feedthru design. The reference and creep test capsule designs have been completed and drawings released. Fabrication techniques have been specified for each of the capsule piece parts. Screening tests have been completed for the braze alloys in the pressure-electrical feedthru assembly. Also preliminary results from feasibility tests indicate back extrusion may provide a suitable backup to deep drawing of the T-111 structural shell. Fabrication and assembly tooling designs have been initiated and the preliminary weld development and quality assurance plans completed. Preliminary results from the coating development tests show that α(alpha) phase Al_2O_3 can be laid down by chemical vapor deposition. Preliminary indications are that a repeatable Al_2O_3 coating process without undue contamination of the substrate is feasible. The design of the coupon compatibility stacks started. The heater and vacuum systems for the coupon compatibility tests are being modified and checked out. Modification designs for the creep test heater and vacuum systems are in progress. Design of the helium pressure system for creep testing is completed and fabrication of the system has started. Alternate methods of measuring in-test strain are being evaluated. (auth)

4356 HIGH-TEMPERATURE COMPATIBILITY TESTING OF RADIOISOTOPE FUEL-CONTAINER SYSTEMS. Andelin, R. L.; Watrous, J. D.; Ferguson, W. E. Trans. Amer. Nucl. Soc., 10: 430-1 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4357 DESIGN CONSIDERATIONS FOR SPACE POWER CAPSULES BURIED IN SOIL. Easton, C. R. (Douglas Aircraft Co.,

Inc., Santa Monica, Calif.). Trans. Amer. Nucl. Soc., 10: 436-7 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4358 RADIOISOTOPE EDUCATIONAL PROGRAM AT ARGONNE NATIONAL LABORATORY. Oestmann, Mary Jane (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 438-9(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4359 RADIATION SOURCES FOR THE NASA-AMES BIOSATELLITE PROGRAM. Allen, C. H. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 453(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4360 DEVELOPMENT OF HIGH-TEMPERATURE ISOTOPE HEAT SOURCES: ^{147}Pm. Cooper, R. S.; Andelin, R. L.; Robinson, R. K. Trans. Amer. Nucl. Soc., 10: 453-4(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4361 USE OF RADIOISOTOPES IN SELECTING "CRISPHEAD" LETTUCE FOR HARVESTING. Garrett, Roger E.; Talley, Wilson K. (Univ. of California, Davis). Nucl. Appl., 3: 745-9(Dec. 1967).
A method has been developed for obtaining indications of the diameter and density of lettuce heads prior to harvest without physically contacting them. As a head passes through a collimated beam, the reduction in transmission is integrated to indicate mass. The interval of reduced signal is used to indicate size. The method offers improved selection for mechanical harvesting, higher speeds of operation, and less damage than with mechanical selection. (auth)

4362 ATMOSPHERIC BURNUP OF A ^{238}Pu GENERATOR. Krey, P. W. (Health and Safety Lab., New York). Science, 158: 769-71(Nov. 10, 1967).
The stratospheric inventory of the plutonium-238 resulting from the disintegration of a nuclear auxiliary power generator (SNAP-9A) in early 1966 accounts for essentially all the plutonium present in the original generator that reentered the atmosphere. Consequently, the pyrophoric ^{238}Pu must have completely burned up during reentry and ablated into small particles. The arithmetic mean of the distribution of the ^{238}Pu particle size was estimated to be 10 millimicrons, which confirms this conclusion. (auth)

4363 USE OF NEUTRON-ACTIVATED MOLYBDENUM DISULPHIDE FOR SOLVING LUBRICATION AND WEAR PROBLEMS. Wagner, K. (Institut fuer Physikalische Chemie, Berlin). Isotopenpraxis, 3: 358-61(Sept. 1967). (In German).
During neutron activation of molybdenum disulfide (24 hr, $\Phi = 2 \times 10^{13}$n cm^{-2} s^{-1}) in a nuclear reactor ^{99}Mo is produced. Experiments with metallic pins gliding or pressed on metal plates (steel, Cu, Ag) show that activated MoS_2 may successfully be used in studying lubrication and wear mechanisms by determination of the adhering MoS_2 by scintillation counting and by evaluation of autoradiographs. The radioactivity obtained allowed about 10^{-5} mg MoS_2 to be measured. (auth)

4364 TABULATED VALUES OF THERMAL DIFFUSION FACTORS FOR VARIOUS ISOTOPIC GASEOUS MIXTURES. Vasaru, Gh. (Inst. for Atomic Physics, Cluj). Isotopenpraxis, 3: 368-74(Sept. 1967).
Numerical values of thermal diffusion factors, αT, were calculated for the isotope systems of H_2, He, CO, N_2, O_2, and CH_4 as a function of reduced temperature T^* in the Kihara first and second approximations for both the exp-6 molecular model and the Lennard-Jones (12,6) model. (auth)

4365 EXPERIMENTAL STUDY OF THE THERMOENERGETIC BEHAVIOR OF AN ISOTOPE-SEPARATION INSTALLATION. Peculea, M.; Bolian, M.; Fatu, C. Rev. Chim. (Bucharest), 18: 524-9(Sept. 1967). (In Rumanian).
An installation intended for studying optimum separation regimes is described and the agreement between results obtained from this study and theoretical estimations of the thermodynamic behavior of the installation, the thermal equilibrium of the column, and the existence of some minimum values for the cost of the isotope produced are discussed. In the zone of these minimum values, the separation column and the component elements of the installation can be operated with a good thermal stability in time. Study of the column type showed the possibility of producing an isotope-separation installation working at optimum economic parameters. (auth)

4366 RADIOIZOTOPNYE METODY KONTROLYA I IZMERENIYA UROVNEI. (Radioisotopic Methods for Control and Level Gauging). Rudanovskii, A. A.; Krez, D. P. Moscow, Atomizdat, 1967. 136p.
The advantages and disadvantages of the radioisotopic method of control and level gaging are described. The basic properties of radioisotopic level gages are analyzed and the problems of selection, operation, and economics are discussed. The performance of level gages in the automatic control of various technological processes is analyzed. Radioisotopic level gages are categorized according to the principles of their performance and the methods of their application. (R.V.J.)

Materials Testing

Refer also to abstracts 4363, 4503, 4540, and 4560.

4367 (SC-DR-67-718) AMSA FUEL CAPSULE IMPACT TESTS. Dalby, W. J. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1967. 163p. Dep. CFSTI.
A three-phase program was conducted to evaluate the impact resistance of the fuel capsule for the AMSA application. The fuel capsule may reasonably be expected to provide fuel containment under all except the most adverse conditions. Impacting the bare capsule at 185 to 200 percent of the experimentally determined sea level equilibrium velocity of approximately 340 ft/sec into soil and concrete targets did not appear to significantly impair the fuel containment capability of the capsule. Impacting the bare capsule into a rigid target (granite) at velocities as low as 85 percent of the experimentally determined sea level equilibrium velocity of 340 ft/sec, with the cylindrical axis of the capsule at 35 to 55 degrees with the normal to the target face and the velocity vector normal to the target face, ruptured the capsule. (auth)

4368 USE OF BETATRONS IN DEFECTOSCOPY OF REFRACTORY CONSTRUCTION MATERIALS. Vorob'ev, V. A. (Tomsk Polytechnic Inst., USSR). Ogneupory, No. 9, 58-60 (Sept. 1967). (In Russian).
Use of bremsstrahlung with a maximum energy from 10 to 30 MeV for control tracing of imperfections in compact chammote and magnezite brick was investigated. The results obtained indicated that that the betatron with maximum energy up to 30 MeV can be used for penetrating over 2m thick brick and could be utilized for defectoscopy of refractory masonry of heat generating equipment. (R.V.J.)

4369 APPLICATIONS OF NEUTRON RADIOGRAPHY. Berger, Harold (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 441-2(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4370 NEUTRON RADIOGRAPHY IN THE EBR-II FUEL CYCLE FACILITY USING AN ISOTOPIC NEUTRON SOURCE. Cutforth, D. C.; Aquino, V. G. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 10: 442(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4371 TOWARD NEUTRON RADIOGRAPHY OF RADIOACTIVE OBJECTS IN HOT CELLS. Barton, J. P. (CEN, Grenoble, France). Trans. Amer. Nucl. Soc., 10: 443(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4372 FAST-NEUTRON RADIOGRAPHY WITH A NEUTRON GENERATOR. Wood, D. E. (Kaman Nuclear, Colorado Springs, Colo.). Trans. Amer. Nucl. Soc., 10: 443-4(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4373 APPLICATION OF HIGH-RESOLUTION NEUTRON RADIOGRAPHY TO INDUSTRIAL INSPECTION PROBLEMS. Garrett, D. A.; Morris, R. A. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 10: 444-5(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4374 LOW-VOLTAGE AND NEUTRON-RADIOGRAPHIC TECHNIQUES FOR EVALUATING BORON-FILAMENT METAL-MATRIX COMPOSITES. Holloway, J. A. (Air Force Materials Lab., Wright Patterson Air Force Base, Ohio); Stuhrke, W. F.; Berger, H. Trans. Amer. Nucl. Soc., 10: 445(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4375 APPLICATION OF NEUTRON RADIOGRAPHY TO HEAT-PIPE DIAGNOSTICS. Moss, Richard A. (Princeton Univ., N. J.). Trans. Amer. Nucl. Soc., 10: 445-6(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4376 NEUTRON RADIOGRAPHY APPLICATIONS ON GENERAL ELECTRIC. Hoyt, J. L.; Porter, C. E.; Wilkinson, C. D. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 10: 446-7 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4377 THE ALPHA–BETA–GAMMA LABORATORY OF THE EUROPEAN INSTITUTE FOR TRANSURANIUM ELEMENTS. EQUIPMENT USED FOR THE POSTEXAMINATION OF PLUTONIUM FUELS. Coquerelle, Michel (EURATOM, Karlsruhe, Ger.). Trans. Amer. Nucl. Soc., 10: 686 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4378 BATTELLE-COLUMBUS MECHANICAL TESTING HOT CELL. DeMastry, John A.; Lusk, E. C.; Gates, John E. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 10: 686-7 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4379 RADIOGRAPHIC NONDESTRUCTIVE TESTING METHOD. Kastner, Jacob; Berger, Harold (to U. S. Atomic Energy Commission). U. S. Patent 3,359,419. Dec. 19, 1967.

A method for obtaining a radiographic image of a sample is described. An ionizing-radiation-sensitive water-white thermoluminescent material is mounted adjacent the sample. A radiation beam is generated and the thermoluminescent material is exposed thereto via said sample. The thermoluminescent material is then excited to cause luminescence thereof and light released by the thermoluminescent material during luminescence is recorded to give a radiographic image of the sample. (auth)

4380 LIFT-OFF COMPENSATION FOR EDDY CURRENT TESTERS. Peugeot, Richard S. (to U. S. Atomic Energy Commission). U. S. Patent 3,358,225. Dec. 12, 1967.

A system is described where an impedance bridge having a source of constant oscillations and voltage coupled thereto is utilized to compare the impedance of an eddy current probe, positioned in close proximity to a conductive sample under inspection, with a standard impedance to provide separated outputs of the reactive and resistive components of imbalance of the impedance bridge. Means are provided for selecting a predetermined portion of one of the outputs and combining it with the other output to provide a signal which is coupled to a readout device for indicating the thickness of the sample under inspection. The selected, predetermined portion of said one output is such that the effect of slight variations in probe-to-sample spacing during inspection of the sample is minimized. (AEC)

Protective Structures

4381 (ABS-THH-1034) ANLEITUNG ZUM GEBRAUCH DER BEI DER ARBEITSGRUPPE FUER BAUTECHNISCHEN STRAHLENSCHUTZ ZUR VERFUEGUNG STEHENDEN RECHENPROGRAMME. III. CDC 1604 A: MAC-RAD, GAMMONE, PHOEBE, SDC, ø5R; LGP 21: TESIW, PIP, ZIP, LLG. (Instruction for the Use of the Computer Programs Available for the Work Group for Construction Techniques in Radiation Protection. III. CDC 1604A: MAC-RAD, GAMMONE, PHOEBE, SDC, ø5R; LGP 21: TESIW, PIP, ZIP, LLG). Sasse, S.; Schubart, H.; Vogt, H. G.; Wueneke, C. D. (Technische Hochschule, Hanover (West Germany). Arbeitsgruppe fuer Bautechnischen Strahlenschutz). Feb. 1967. 54p. (In German). Dep.

The individual units which are necessary for the utilization of the programs on the CDC 1604 A and some modifications necessary for a flexible applicability are treated in the instructions on the use of specific computer programs. (J.S.R.)

4382 (ORNL-P-3427) PROJECT HARBOR IN RETROSPECT. Bresee, J. C. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 8p. (CONF-670949-1). Dep. CFSTI.

From 2nd Emergency Operations Symposium, Santa Monica, Calif.

Possible changes in the results and conclusions of Project Harbor after four years are presented. Project Harbor was a civil defense study sponsored by the National Academy of Sciences at Woods Hole, Mass. in Aug. and Sept. 1963. Changes might result from the international situation, advances in weapons and defense technology, and modified domestic priorities. Changes caused by changes in emergency organizations, emphasis on shelter concept, and increased recognition of the interdependence of ballistic missile defense and civil defense are discussed. (F.S.)

4383 APPLICATIONS AND LIMITATIONS OF A MATRIX TREATMENT OF NEUTRON DIFFUSION. Huddleston, C. M.; Eaton, M. L. (Naval Civil Engineering Lab., Port Hueneme, Calif.). Trans. Amer. Nucl. Soc., 10: 732-3 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4384 REFLECTION OF HIGH-ENERGY PHOTONS FROM SEMI-INFINITE HOMOGENEOUS SLABS BY 'NVARIANT IMBEDDING TECHNIQUES. Kaiser, R. E.; Mingle, J. O. (Kansas State Univ., Manhattan). Trans. Amer. Nucl. Soc., 10: 733 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4385 COMPARISON OF OGRE-P1 MONTE CARLO CALCULATIONS WITH NRDL EXPERIMENTS FOR GAMMA-RAY PENETRATION THROUGH SLABS. Barkley, B. L.; Chatterton, M. S.; Deutsch, R. W. (Catholic Univ. of America, Washington, D. C.). Trans. Amer. Nucl. Soc., 10: 734 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4386 RADIATION SHIELDING STUDIES AT THE CANADIAN DEFENCE RESEARCH BOARD. Clifford, C. E. (Defence Research Board, Ottawa, Ont.). Trans. Amer. Nucl. Soc., 10: 722 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4387 ENGINEERING METHOD: PROBLEMS OF TEACHING AND THE USE IN ACTUAL BUILDING DESIGN AND ANALYSIS. Smyrl, E. (Montana State Univ., Bozeman). Trans. Amer. Nucl. Soc., 10: 722 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4388 EXTENSION OF THE ENGINEERING METHOD TO IMPROVE FALLOUT PROTECTION FACTOR CALCULATIONS FOR BASEMENTS. French, R. L. (Radiation Research Associates, Inc., Fort Worth, Tex.). Trans. Amer. Nucl. Soc., 10: 722-3 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4389 DOSE RATES IN AN OPEN BASEMENT IN A SIMULATED FALLOUT FIELD. Stathoplos, A.; Wills, L. (Radioptics, Inc., Cambridge, Mass.). Trans. Amer. Nucl. Soc., 10: 723-4 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4390 DESIGN DATA FOR DUCTED ENTRANCEWAYS. Gardner, Leonard B. (Navy Civil Engineering Lab., Port Hueneme, Calif.). Trans. Amer. Nucl. Soc., 10: 724-5 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4391 RADIATION PROPAGATION AND SHIELDING EXPERIMENTS AT THE BREN TOWER FACILITY. Auxier, J. A. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 726 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4392 SHIELDING OF GROUND-BASED STRATEGIC WEAPON SYSTEMS AGAINST INITIAL NUCLEAR RADIATION. Ray, E. (Aerospace Corp., San Bernardino, Calif.). Trans. Amer. Nucl. Soc., 10: 726 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4393 SIMPLIFIED COMPUTATIONAL METHOD FOR INITIAL RADIATION SHIELD DESIGN. Karcher, R. H. (Holmes and Narver, Inc., Los Angeles, Calif.). Trans. Amer. Nucl. Soc., 10: 726-7 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4394 SEMIEMPIRICAL FORMULA FOR DIFFERENTIAL DOSE ALBEDO FOR FAST NEUTRONS ON VARIOUS MATERIALS. Song, Yo Taik (Naval Radiological Defense Lab., San Francisco, Calif.). Trans. Amer. Nucl. Soc., 10: 727-8 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4395 ANALYSIS OF ABOVEGROUND FALLOUT SHELTER VENTILATION REQUIREMENTS. Baschiere, R. J. (General

American Transportation Corp., New York); Lokmanhekim, M.; Moy, H. C.; Engholm, G. ASHRAE (Amer. Soc. Heat., Refrig. Air-Cond. Eng.) J., 71: 101-14(1965).

In selecting the ventilation equipment for an aboveground fallout shelter, it is necessary to know the number of shelter occupants, the geographical location, and the shelter size and construction. The number of occupants establishes the level of latent heat produced in the shelter. Geographical location determines the ambient weather from which a weather design criteria can be obtained. The physical size and construction defines the heat transfer coefficients required to compute heat transfer to and from the shelter. An analytical model was determined for predicting psychrometric conditions that develop in aboveground shelters. (F.S.)

Radioactive Material Handling

Refer also to abstracts 4272 4288, 4303, 4331, 4332, 4504, and 4838.

4396 RADIATION FACILITY FOR USE WITH HAZARDOUS CHEMICAL SYSTEMS. Huszagh, D. W.; Kukacka, L. E.; Steinberg, M. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 678 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4397 FIRE PROTECTION IN CHEMISTRY HOT CELLS BY USE OF HALON-1301. Franck, T. E.; Youngquist, C. H. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 679 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4398 SAFETY EXPERIENCE AND THE CONTROL OF HAZARDS IN HOT CELL OPERATIONS AT HARWELL. Ritchie, A. B. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Trans. Amer. Nucl. Soc., 10: 679 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4399 HEALTH PHYSICS AT THE LRL TRANSURANIC PROCESSING FACILITY. Denham, D. H. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 680 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4400 SAFETY REVIEW PROCEDURES FOR HOT CELL AND RADIOCHEMICAL PROCESSING FACILITIES AT ORNL. Burch, W. D.; Arehart, T. A. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 680-1 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4401 SAFETY REQUIREMENTS FOR DESIGN OF THE FFTF FUEL EXAMINATION FACILITIES. Boyd, C. L. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 681 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4402 SHIELDED FUEL EVALUATION FACILITY (SFEF). Ludlow, J. O.; Eckels, T. W.; Graae, J. E. A.; Nelson, P. A.; Slawecki, M. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 682-3 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4403 THE FONTENAY-AUX-ROSES RADIOMETALLURGY LABORATORY. EQUIPMENT AND STARTUP AT ALPHA-BETA-GAMMA CELLS. Valentin, A.; Hayet, L.; Faugere, J. L. (CEA, Paris). Trans. Amer. Nucl. Soc., 10: 683 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4404 THE LIVERMORE NEUTRON-SHIELDED CHEMISTRY CELLS. I. CONFIGURATION AND PHILOSOPHY. Coops, M. S.; Hanson, C. L. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 10: 683-4 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4405 THE LIVERMORE NEUTRON-SHIELDED CHEMISTRY CELLS. II. TRANSFER SYSTEMS. Hanson, C. L.; Coops, M. S.; Parkison, C. D. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 10: 684-5 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4406 THE HANDLING OF KILOGRAM QUANTITIES OF ^{233}U BY DIRECT AND REMOTE METHODS AT THE OAK RIDGE NATIONAL LABORATORY CENTRAL DISPENSING FACILITY. Parrott, J. R.; Brooksbank, R. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 688 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4407 CONVERSION OF A BETA-GAMMA HOT CELL FOR EXAMINATION OF PLUTONIUM-ENRICHED FUEL CAPSULES. Stimmell, G. L. (General Electric Co., Pleasanton, Calif.); Corrigan, J. E.; Howard, N. C. Trans. Amer. Nucl. Soc., 10: 673 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4408 EQUIPMENT FOR DISPOSAL OF HIGH-LEVEL SOLID WASTES FROM THE EBR-II FUEL CYCLE FACILITY. Bernstein, G. J. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 673-4 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4409 REMOTELY OPERATED CLEANUP TOOLING FOR NRU REACTOR VESSEL HEADER SEALS. Astill, C. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Amer. Nucl. Soc., 10: 665-6 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4410 REMOTE DISASSEMBLY AND EXAMINATION OF THE PM-2A REACTOR VESSEL. Hagmann, D. B. (Idaho Nuclear Corp., Idaho Falls.). Trans. Amer. Nucl. Soc., 10: 666 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4411 PORTABLE ALPHA-GAMMA CELL FOR NONDESTRUCTIVE EXAMINATION OF IRRADIATED FERMI SUBASSEMBLIES. Duffy, J. G.; Edwards, J. J.; Matte III, J.; White, J. R. (Atomic Power Development Associates, Inc., Detroit). Trans. Amer. Nucl. Soc., 10: 666-8 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4412 POSTIRRADIATION EXAMINATION OF THE PM-3A TYPE I, SERIAL 2 CORE. Brown, John B. Jr.; Storhok, Victor W.; Gates, John E. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 10: 668-9 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4413 INERTING OF THE BATTELLE-COLUMBUS LOW-LEVEL BETA-GAMMA CELL. Matolich, J.; Martin, R. L. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 10: 669 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4414 EBR-II PLANT EQUIPMENT FOR OXIDATION OF MELT REFINING SKULLS. Miller, W. E.; Bernstein, G. J.; Fryer, R. M.; Malecha, R. F.; Paul, R. C.; Slawecki, M. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 670 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4415 SRP INTERMEDIATE-LEVEL ANALYTICAL CELL FACILITY. Lethco, A. J.; Davies, M. D. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 10: 670-1 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4416 PROCESSING OF FUEL ELEMENTS IRRADIATED IN THE RAPSODIE FAST REACTOR: MECHANICAL TREATMENT OF ELEMENTS BEFORE DISSOLUTION. Boundry, J. C.; Cantel, J.; Gey, J. F.; Conche, F. (CEA, Paris). Trans. Amer. Nucl. Soc., 10: 671 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4417 EXAMINATION TECHNIQUES FOR HIGH BURNUP U–Pu FUEL ELEMENTS FOR FAST-BREEDER REACTORS. Koprowski, B. J.; Brown, F. L. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 671-2 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4418 ATTILA: A HOT CELL FACILITY FOR REPROCESSING STUDIES ON IRRADIATED FUELS BY FLUORIDE

VOLATILITY TECHNIQUES. Bourgeois, M.; Lefort, G.; Manevy, G.; Rochedereux, Y. Trans. Amer. Nucl. Soc., 10: 672 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4419 STUDY ON THE SOLIDIFICATION OF HIGH-LEVEL RADIOACTIVE LIQUID WASTE WITH CEMENT. Iwai, Shigehisa; Inoue, Yoriteru (Kyoto Univ.). Hoken Butsuri, 1: No. 1, 12-19(Sept. 1966). (In Japanese).

The treatment and disposal of radioactive wastes from fuel reprocessing plant will be of great importance within a few years. Studies on the possibility of disposing these wastes into the deep sea are needed. Neutralized liquid waste having the same chemical composition as that from Purex-reprocessing was solidified with cement, then the compression strength of the specimen and the factors affecting its strength were examined. Results are as follows: generally, compression strength was reduced exponentially with the increase of waste-cement ratio weight or with the dilution of the waste with tap water; the largest strength, 680kg/cm^2, was obtained in the case of solidifying the waste neutralized with $Ca(OH)_2$ under conditions of no dilution of the neutralized waste, waste-cement ratio of 120% and curing time of 28 days, in neutralization with NaOH, the largest strength was 420 kg/cm^2; volume increase ratio between the solidified cement specimen and the waste water before solidification was 1.5 in the case with $Ca(OH)_2$ and 1.7 with NaOH under the same conditions as above; and factors affecting strength were dilution of the waste and waste-cement ratio when $Ca(OH)_2$ was used as the neutralizer, and waste-cement ratio and curing time using NaOH. (NSA of Japan)

4420 CONTROL OF LIQUID RADIOACTIVE WASTES IN JPDR. Katoh, Jinzo; Misaka, Tsuyoshi (Japan Atomic Energy Research Inst., Tokyo). Hoken Butsuri, 1: No. 2, 55-63(Dec. 1966). (In Japanese).

The disposal of radioactive waste materials resulting from the operation of nuclear power reactors is a very important problem in the design and operation of nuclear power plants. The control or regulation of liquid radioactive waste and the experimental results of the JPDR for the past three years are reviewed. Origin of the radioactive waste is mainly treated water in regeneration of radioactive resin and cooling water. Based on the experimental results of 1000 hr continuous operation, the daily liquid waste discharged was about $26m^3$ in volume with an activity of 900 μCi. These radioactive liquid wastes are treated by filtration and demineralized or stored in the decay tank in some cases. If liquid waste had less than 10^{-4} μCi/ml, it was discharged to a canal which lead to the ocean. This canal carries about 6000 m^3/hr of turbine condenser cooling water which dilutes the concentration of liquid waste to a factor of about 3000. The concentration of radioactive isotopes in the liquid wastes leaving the plant site is well below the MPC limits for unrestricted areas as established by the ICRP and Japanese Government authorities. (NSA of Japan)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 5736.

4421 A REVIEW OF THE METHODS OF MEASUREMENTS OF THE ACTIVITY AND RADIATION PURITY OF RADIOISOTOPES. Jablonska, J.; Lada, W.; Pochwalski, K.; Radoszewski, T. (Inst. of Metrology of Radioactive Isotopes, Warsaw. Inst. of Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 43-50 (1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

A review of the methods of radioisotope activity measurements is given. Taking into account the source activity and the kind of radiation various detectors are used. They are: G-M counters, proportional counters, scintillation counters and ionization chambers. The range of measurement of each method and obtained accuracies are given. The measurements of the radiation purity of radioisotopes by means of scintillation spectrometers are also described. (auth)

General Detectors and Monitors

Refer also to abstracts 4056, 4187, 4188, 4288, 4543, 5708, and 5867.

4422 (AERE-R-5179) MEASUREMENTS OF THE GAMMA ACTIVITIES OF COBALT AND OTHER NEUTRON FLUX MONITORS USING AN IONISATION CHAMBER. Cabell, M. J.; Wilkins, M. (Atomic Energy Research Establishment, Harwell (England)). July 1967. 44p. Dep. CFSTI. UK 7s. 0d.

An apparatus which can be used to determine the absolute γ-activities of irradiated cobalt monitors (and the ^{60}Co equivalent of the activities of other monitors) is described, and its characteristics specified. It incorporates an ionization chamber. By indirectly relating the activities of the monitors to a number of ^{60}Co primary standards it was shown that they can be determined absolutely with an accuracy of ±3% (2σ) or better, if they are in the range 4 microcuries to 50 millicuries, or with an accuracy of ±5% (2σ) if they are in the range 1 to 4 microcuries. Experimental results are processed by a specially written program, called CIMCA, which has been prepared for the S2 compiler of the IBM 7030 (Stretch) computer at AWRE, Aldermaston. (auth)

4423 (CLOR-65/D) CONVEX-TYPE SILICON DETECTOR. Dabrowski, A.; Roman, J. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1967. 8p. Dep.

A convex-type silicon surface-barrier detector with hemispherical sensitive surface of 4.5 cm^2 was fabricated. It is designed for use in an electrostatic precipitator, as a collecting electrode for direct counting of alpha particles of radon decay products in air. The energy resolution measured at room temperature of about 25°C was better than 1.5% for 6 MeV alpha particles. (auth)

4424 (CONF-671027-2) DESIGN AND EVALUATION OF A COMPUTER CONTROLLED WHOLE BODY RESEARCH SCANNER. Cook, W. E.; Kramer, C. E.; Brill, A. B. ([Vanderbilt Univ., Nashville, Tenn.]). [nd]. 10p. Dep. CFSTI.

From Nuclear Medicine Society, Lexington, Ky.

The design of a whole-body scanner using sodium iodide scintillation detectors is presented. The digital logic interfaces for data collection, analysis, storage, and display are discussed. (W.H.K.)

4425 (EGG-1183-2158) A STUDY OF THE NONLINEAR RESPONSE OF NE 102 AND MEL 150-C SCINTILLATORS. Technical Report Number S-401-R. Stevens, J.; Knowlen, R. B. (EG and G, Inc., Santa Barbara, Calif.). Oct. 1967. Contract W-7405-eng-48. 57p. (UCRL-13323). Dep. CFSTI.

For California Univ., Livermore. Lawrence Radiation Lab.

Plastic scintillators NE 102 and MEL 150-C were measured to determine the peak dose rate for which scintillator light output is linearly proportional to incident flux. These measurements were performed by bombarding 80-mil-thick scintillating discs with 12-MeV electrons obtained from the EG&G/AEC linac. The scintillators' light output was measured with a photodiode, and the resulting signal was compared to that from a Faraday cup which measured the incident electron flux. Nonlinear behavior was observed using pulse widths between 0.5 μsec and 6 nsec. Maximum observed nonlinearity was about 30% for the leading edge. Greater nonlinearity was observed for the back half of the pulse. The total dose or dose rate required to drive NE 102 into nonlinearity is approximately twice that for MEL 150-C. The data indicated that for pulse widths between 30 nsec and 0.5 μsec, NE 102 becomes nonlinear at a total dose of 2.3×10^{13} γ MeV/cm^2, while MEL 150-C becomes nonlinear at 1.1×10^{13} γ MeV/cm^2. For shorter pulses, nonlinearity is a function of dose rate rather than total dose. For a 6-nsec excitation, NE 102 becomes nonlinear at 8×10^{20} γ MeV/cm^2/sec, while MEL 150-C becomes nonlinear at 5×10^{20} γ MeV/cm^2/sec. (auth)

4426 (JUL-495-RX) DIE BESTIMMUNG DER FLUENZ THERMISCHER NEUTRONEN MIT HILFE VON KOBALTSONDEN. (Determination of the Thermal Neutron Flux with Cobalt Probes). Weise, L. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). July 1967. 40p. (In German). Dep.

For the determination of the thermal neutron flux, and of the thermal neutron flux integrated over irradiation time, the use of Co probes as activation detectors are suitable. The nuclear reaction $^{59}Co(n,\gamma)^{60}Co$ possesses a series of advantages which make it very suitable for this purpose. The present study treats first the principle of the methods based on neutron capture processes for the measurement of the thermal neutron flux. Measurements of thermal neutron fluxes by this method were carried out. A description is given of the devices developed for this purpose and the errors in the results obtained are discussed. (tr-auth)

4427 (LYCEN-6766) RESOLUTION EN TEMPS DES DETECTEURS AU GERMANIUM COMPENSE AU LITHIUM. (Time Resolution of Lithium-Compensated Germanium Detectors). Balland, Jean-Claude (Lyon Univ. (France). Institut de Physique Nucleaire). Sept. 1967. 111p. (In French). Dep.

Thesis.

An attempt is made to develop a simplified formulation of the problem of time measurements using Ge(Li) detectors by taking into consideration the physical characteristics of these detectors and the limitations due to the associated electronic instrumentation. The properties of these detectors and the physical processes for gamma detection are reviewed. The electronic problems connected with energy resolution are then analyzed. Time measurements are studied theoretically. The instrumentation used is described. The amplification and discriminator circuits are given. Experimental results obtained in time resolution are shown graphically. (J.S.R.)

4428 (NP-17063) DIFFERENTES METHODES DE DETECTION DES NEUTRONS RAPIDES PRODUITS PAR BOUFFEES. (Various Methods for Fast Neutron Detection). [Herbaut, Y.] (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [Nov. 30, 1965]. 24p. (In French). Dep.

The possibilities of using the various methods developed for the measurement of constant neutron fluxes for the measurement of the flux of pulsed neutrons produced by accelerators, especially in the case of very short bursts, were studied. Methods based on the direct determination of fast neutrons and their detection after thermalization were both analyzed with respect to their capacities for detection of neutron bursts. The results showed that it would be advantageous to detect the fast neutrons directly without thermalizing them. In this case the only method valid for very short bursts is the utilization of isomers with short half lives such as ^{209}Bi. However this method has a very low sensitivity and is very complex. Moreover its utilization is limited in pulsation frequency. By the thermalization of neutrons the field of possibilities is expanded. It appears that the use of B ionization chambers is the most satisfactory. These chambers give the results in the form of a continuous current measurement. They are not limited with respect to the duration of the neutron bursts nor to the pulsation frequency. They have good sensitivity and are simple in construction. (tr-auth)

4429 (NP-17072) EXPERIMENTELLE BESTIMMUNG DER EFFICIENCY EINES NaJ(Tl)-SZINTILLATIONSDETEKTORS FUER DIE γ-STRAHLEN VON ^{137}Cs UND ^{60}Co IN FREISTRAHL-GEOMETRIE. (Experimental Determination of the Efficiency of a NaI(Tl) Scintillation Detector for the γ-Rays of ^{137}Cs and ^{60}Co in a Free Radiation Geometry). Christmann, Burkhard (Freie Universitaet, Berlin (West Germany). I. Physikalisches Institut). 1966. 63p. (In German). Dep.

The experimentally determined integral efficiency of a 1.5 inch × 2 inch NaI(Tl) cylindrical crystal in free radiation geometry was given for distances up to 20 cm. ^{60}Co (mean quantum energy of 1.25 MeV) and ^{137}Cs (662 keV) solutions of various activity were used as sources. The absorption in a spherical source was calculated and an estimation was made of the effect of the expansion of

the source on the measured efficiency. A comparison of the results with the calculated efficiency for a point source showed that the measured value in the middle of the distance region considered agrees with the calculated values. At the largest gaps however it is approximately 7% larger and at distances of one cm approximately 15% smaller. The differential spectrum was used for detection of the quanta which reach the crystal. The effect of the nonproportionality between the γ energy or the electron energy and the luminescent yield of the crystal was considered on the differential spectra. An additional correction was given both for the differential spectrum and for the integral measurement from the time coincidence of the γ quanta in ^{60}Co. The error of the measurements by scattering in the crystal environment was experimentally determined and eliminated. (tr-auth)

4430 (ORO-3224-12) X-RAY ANALYSIS USING RADIOISOTOPE SOURCES. Interim Technical Report No. 3. Rhodes, J. R.; Furuta, T.; Hall, J. D. (Texas Nuclear Corp., Austin). July 14, 1967. Contract AT(40-1)-3224. 101p. Dep. CFSTI.

A portable, battery-operated X-ray fluorescence analyzer weighing 15 lbs has been developed. It consists essentially of a NaI(Tl) scintillation counter probe and an electronic unit with a single channel pulse-height analyzer and reversible scaler. Radioisotope X-ray sources are used for excitation of the sample and, where necessary, balanced filters for resolution of neighboring characteristic X-rays. Emphasis has been placed on designing and producing an instrument that is convenient to operate in laboratory, factory or field conditions, and that can equally well be used to measure extended surfaces, such as rock faces, or finite samples in the form of powders, briquettes or liquids. Preliminary feasibility studies are reported for determination of sulfur and ash in coal, calcium and iron in cement raw mix, copper in copper ores, gold in gold ore concentrates and silver in silver ores. In the last-named analysis comparisons are made with alternative methods of excitation using source target assemblies and detection using a high resolution cooled Si(Li) detector. Sensitivities of determination, based on counting statistics obtained in count times of 10 to 100 seconds, range from 0.002% for silver in ores to 0.2% for sulfur in coal. Matrix effects were reduced or eliminated by the use of nomograms or by semi-empirical correction factors based on attenuation or scattering coefficients. (auth)

4431 (UCRL-70545) PARALLELING PLANAR Ge(Li) DETECTORS FOR COUNTING LARGE VOLUME BIOLOGICAL SAMPLES. Saunders, E. W.; Maxwell, C. J. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 25, 1967. Contract W-7405-eng-48. 20p. (CONF-671026-5). Dep. CFSTI.

From 14th Nuclear Science Symposium, Los Angeles, Calif.

Four planar Ge(Li) detectors have been operated in an array, in parallel electrically, and connected to a single preamplifier. The total active volume is 28 cm^3. The photopeak efficiency of the four-detector array at 1.33 MeV is about 4.8 times greater than the efficiency of one 7 cm^3 detector. The resolution is 2.90 keV FWHM at 1.33 MeV and 2.01 keV FWHM at 122 keV. Some misalignment of the individual detector photopeaks is observed, probably caused by contact resistance. A technique which allows alignment of the peaks is presented. (auth)

4432 FAST-REACTOR SPECTRUM INVESTIGATIONS ON THE FACILITIES SUAK AND SNEAK AT KARLSRUHE. Bluhm, H.; Fieg, G.; Lalovic, M.; Stegemann, D.; Wattecamps, E.; Werle, H. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Trans. Amer. Nucl. Soc., 10: 576-7(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4433 NEUTRON SPECTRUM MEASUREMENTS IN ZPR-3, -6, AND -9 USING HYDROGEN-RECOIL PROPORTIONAL COUNTERS. Bennett, E. F.; Gold, R. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 577(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4434 MEASUREMENT OF NEUTRON FLUX SPECTRA BY A MULTIPLE-FOIL ACTIVATION ITERATIVE METHOD AND COMPARISON WITH REACTOR PHYSICS CALCULATIONS AND SPECTROMETER MEASUREMENTS. McElroy, W. N.; Berg, S.; Crockett, T. B. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 577(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4435 FAST-NEUTRON SPECTRUM MEASUREMENTS BY MEANS OF NUCLEAR EMULSIONS. Beets, C. (EURATOM-CEA, Cadarche, France). Trans. Amer. Nucl. Soc., 10: 577-8 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4436 FAST-NEUTRON RESPONSE FUNCTION CALCULATIONS FOR POLYETHYLENE-MODERATED FISSION CHAMBERS. Greene, N. M.; Mynatt, F. R. (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc., 10: 640-1(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4437 COPPER-ALUMINUM ABSOLUTE FAST- AND THERMAL-NEUTRON FLUX MONITOR. Fritzen, Jeffrey F. (Navy Dept., Arlington, Va.); Jester, William A. Trans. Amer. Nucl. Soc., 10: 450-1(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4438 NEUTRON DOSIMETRY STUDIES IN THE EBR-II FOR IRRADIATION DAMAGE EXPERIMENTS. Dahl, R. E.; Jackson, J. L.; Ulseth, J. A.; DePino, A. Jr. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 485-6(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4439 USE OF DIRECTIONAL DETECTORS FOR INVESTIGATING THE RADIATION CHARACTERISTICS OF PLANE ISOTROPIC SOURCES. Varyushchenko, S. B.; Zykov, I. K. At. Energ. (USSR), 23: 251-2(1967). (In Russian).

Problems arising in connection with the estimation of γ-radiation fields from surface sources encountered in areal radiometric surveys by means of directional detectors were examined. In order to select the optimum aperture for isotropic detectors, the recording efficiency, sensitivity of the detector, statistical methods employed, angle of coverage and the background radiation were taken into account. Formulas were derived for shielded detectors with constant sensitivity, conic collimation was used, assuming that the radioactive material was uniformly distributed throughout the surveyed surface. The calculation indicated that for an anisotropic detector, the value of $K(H,\theta)$ (whereby K is a constant, depending on the units chosen, and θ and H indicate the aperture and the height of the detector above the surface) changes strongly with the height. (TTT)

4440 A GASEOUS CHERENKOV POWER-LEVEL MONITOR. Carpenter, John M.; Lehto, Wayne K. (Univ. of Michigan, Ann Arbor). Nucl. Appl., 3: 750-2(Dec. 1967).

A gaseous Cherenkov detector, capable of detecting only high-energy prompt gamma rays in the presence of a significant low-energy flux, was tested as a power-level monitor. Preliminary tests show the net output to be linear with reactor power. Applicability and suggested improvements to the present device are discussed. (auth)

4441 THE STATE OF DEVELOPMENT OF SEMICONDUCTOR RADIATION DETECTORS. Takayanagi, Seiichi (Tokyo Shibaura Electric Co., Ltd.). Genshiryoku Kogyo, 13: No. 4, 37-42(Apr. 1967). (In Japanese).

Many institutes in Japan have conducted researches on semiconductor radiation detectors in an effort to develop devices, clarify the phenomena, or develop the measuring circuits. The state of development of semiconductor radiation detectors in Japan is described. (TSS) (NSA of JAPAN)

4442 STABILITY OF NISHINA-TYPE IONIZATION CHAMBER AND ITS APPLICATION TO THE DETERMINATION OF PRIMARY COSMIC-RAY SPECTRUM. Inoue, Aoi (Inst. Phys. Chem. Research (Tokyo)). Rika Gaku Kenkyusho Hokoku, 42: No. 3, 43-59(May 1966). (In Japanese).

The secular change of cosmic-ray intensities was examined, utilizing the data obtained from 1951 to 1965 with Nishina-type ionization chambers installed in the Itabashi ward, Tokyo, and on the top of Mt. Nori-Kura. The mechanical stability over a long period of time of the Nishina-type ionization chambers was also checked. The ionization chambers in the Itabashi ward were found to have a gas leak of 100 g/cm^2/year. The value of a correction factor in this connection (i.e., for the gas leakage) gives a large influence upon the determination of primary cosmic-ray variation spectra. For the analysis of the spectra, the advantage of cosmic-ray observations at low latitudes was shown. (NSA of JAPAN)

4443 SIMPLIFIED SOLID-STATE SCINTILLATION COUNTING ON GLASS MICROFIBER MEDIUM IN PLASTIC BAG FOR ^{3}H, ^{14}C, AND ^{36}Cl IN BIOLOGICAL AND ORGANIC MATERIALS. Gupta, Gopi N. (Rockefeller Univ., New York). Anal. Chem., 39: 1911-12(Dec. 1967).

A simple method for radio-assay of biological and organic materials is presented. The sample is impregnated on a glass micro-

fiber medium, wet with a few drops of usual scintillation fluid, sealed in a plastic bag, and counted in a Lucite holder. (W.H.K.)

4444 USE OF RADIOLOGICAL SURVEY INSTRUMENTS AROUND PULSED RADIATION SOURCES. Leake, J. W. (Atomic Energy Research Establishment, Harwell, Eng.). Kerntechnik, 9: 451-3(Oct. 1967).

It is shown that ordinary radiological survey instruments which have been designed for use in continuous radiation fields may, with care, be used to measure mean dose rates in pulsed radiation fields. Pulse type systems have been shown to be usable up to count rates of 0.1 N while most mean current ionization chambers may be used up to $(N^2/s^{-2})R/h$ (or rem/h). (W.H.K.)

4445 STUDY OF A NEUTRON COUNTER WITH HIGH EFFICIENCY AND DEFINED RESPONSE IN THE ENERGY RANGE 0 TO 14 MeV. Picot, A.; Lebars, M.; Haug, R. (Faculte des Sciences, Nancy). Rev. Phys. Appl., Suppl. J. Phys., 2: 218-24 (Sept. 1967). (In French).

A neutron counter whose efficiency varies between 30 and 10% within the energy range 0-14 MeV is studied. It gives an approximate radiation energy measurement and an activity calibration with 10% accuracy. Calibration curves were established by a theoretical study of the counter and they were verified by experimental results. (auth)

4446 VACUUM DIODE DETECTOR FOR MEASURING HIGH INTENSITY GAMMA-RAY FLUX. Ebert, P. J.; Lauzon, A. F. (Univ. of California, Livermore). Contract W-7405-eng-48. Rev. Sci. Instrum., 38: 1747-52(Dec. 1967). (UCRL-70460).

An insensitive gamma-ray detector for measurement of fast rising, transient gamma-ray fluxes has been developed. Linear signals $\geq 5 \times 10^2$ Å has been observed, corresponding to a 1.25 MeV dose rate of $>10^{16}$ R/h. The detector can also be used in the steady state mode where signals $\leq 10^{-12}$ Å can be measured. This current corresponds to a ^{60}Co dose rate of ~20 R/h. Detector design criteria, sensitivity as a function of energy, linearity, and time response are also discussed. (auth)

4447 FURTHER DEVELOPMENTS IN THE APPLICATION OF SCINTILLATION CHAMBERS TO SPACE RESEARCH. Doolittle, R. F.; Graves, C. D. (TRW Inc., Redondo Beach, Calif.). Advan. Electron. Electron Phys., 22B: 823-33(1965).

From Third Symposium on Photo-Electronic Image Devices, London, Sept. 20–24, 1965. See CONF-650991.

The development of a scintillation chamber coupled with an image intensifier tube for space research is described. Included topics are image intensifier tube selection, choice of initial space-physics experiment, design of an appropriate track-forming scintillator, design and fabrication of a film camera suitable for balloon experiments, and image intensifier tube gating and pulse-height analysis. (W.H.K.)

4448 COMPUTER PROGRAMME FOR THE CALCULATION OF RADIOACTIVITY DATA FROM LIQUID-SCINTILLATION COUNTERS FITTED WITH EXTERNAL STANDARDS. Felts, J. M.; Mayes, P. A. (Royal Veterinary Coll., London). Biochem. J., 105: 735-9(Nov. 1967).

A method for transferring data from liquid-scintillation counters to automatic punched-card read-out is described. A method of calibration of an external standard is also presented that supplies sufficient information for the correction of quenched data by computer. A computer programme in FORTRAN IV is described that calculates the data from one isotope, or two isotopes counted simultaneously, and that incorporates features for examining the reproducibility of the input data. With the methods described, quench correction of samples containing either ^{3}H or ^{14}C was accurate until samples were quenched 70%. When the two isotopes were both present in one sample and counted simultaneously, the correction was accurate until the samples were quenched 60%. When quenching was greater than either 70 or 60%, respectively, its correction was still possible but with slightly diminished accuracy and with greater variability. (auth)

4449 DEVICE FOR MEASURING NEUTRON CURRENT DENSITIES HAVING A CONCAVE NEUTRON REFLECTOR. Janner, Karl (to Siemens-Schuckertwerke Aktiegesellschaft). U. S. Patent 3,349,243. Dec. 4, 1963. Priority date Dec. 7, 1962, Germany.

A device for measuring neutron current densities of a determined neutron spectrum is described. The device is composed of a measuring probe responsive to impinging neutrons, a plate made of moderator material and located on one side of the measuring probe, and a concave neutron reflector forming with the plate a chamber surrounding the probe and spaced from the probe by air. The reflector has the shape of a hollow thick-walled truncated cone with the plate of moderator material at the base. (U. S. Pat. Gazette)

4450 GASEOUS MIXTURE FOR USE IN RADIATION DETECTORS. Chameroy, Jean (to Groupement Atomique Alsacienne Atlantique). British Patent 1,090,897. Nov. 15, 1967. Priority date July 9, 1965, France.

A gaseous mixture of dimethyl ether, methylamine, and neon is described for use as a tissue-equivalent material in radiation detectors. The mixture described has a tissue-equivalent response to neutron fluxes and to gamma rays between 10 keV and 10 MeV. (W.H.K.)

4451 FLOW COUNTER FOR MEASUREMENT OF RADIOACTIVE MATERIALS. Wegner, Lutz-Axel; Schurfeld, Hans (to Farbenfabriken Bayer Aktiengesellschaft). British Patent 1,090,745. Nov. 15, 1967. Priority date Mar. 7, 1964, Germany.

Specifications for a gas-flow proportional detector for low-energy radiation are presented. An additional electric field is produced at the aperture of the chamber by an electrical diaphragm system. Data showing the effects of varying this additional field on counting efficiency are included. (W.H.K.)

4452 IMPROVEMENTS IN AND RELATING TO GEIGER–MULLER TUBES. Mackintosh, Ian William (to Mullard Ltd.). British Patent 1,092,431. Nov. 22, 1967. Filed Aug. 28, 1964.

A Geiger–Mueller tube designed to give a fairly level response curve for the lower and higher energy ranges of gamma radiation is described. Part of the envelope is opaque to low-energy radiation, which is capable of directly ionizing the gas filling, and opaque to high-energy radiation. Response curves are included. (W.H.K.)

4453 ACTIVITY COUNTING DEVICE IN MULTICHANNEL ARRANGEMENT. Frayssse, George; Hage, Walter; Pelah, Israel (to European Atomic Energy Community). British Patent 1,091,511. Nov. 15, 1967. Filed Dec. 18, 1963.

The design of a system for measuring the radioactivity of activated foils for neutron flux measurements is presented. The foils are placed on a rotating sample holder and a single detector is used with a multichannel pulse-height analyzer. (W.H.K.)

4454 GAS FLOW NUCLEAR DETECTOR CELL. (to Atomic Energy of Canada Ltd.). British Patent 1,092,797. Nov. 29, 1967. Priority date May 3, 1965, United States.

The design of a scintillation detector cell for detecting low-level radiations in gases in presented. Particular consideration is given to the detection of tritium in air. (W.H.K.)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 5809.

4455 (ANL-7355) PHYSICS DIVISION SUMMARY REPORT, APRIL–JUNE 1967. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 86p. Dep. CFSTI.

The research highlights on the six-gap beta-ray spectrometer, the conversion of the tandem Van de Graaff accelerator, and computer operation of the 60-in. scattering chamber are presented. Also included in the Physics Division's summary are a list of reports presented at meetings, abstracts of papers accepted for publication, a list of publications since the previous summary, and personnel changes in the ANL Physics Division. (B.G.D.)

4456 (JUL-499-RX) EIN SPEKTROMETER ZUR UNTERSUCHUNG DER ENERGIEVERTEILUNG SCHNELLER NEUTRONEN. (A Spectrometer to Investigate the Energy Distribution of Fast Neutrons). Krisch, O. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Aug. 1967. 49p. (In German). Dep.

For investigation of the energy distribution of fast neutrons a telescope spectrometer was built. The recoil protons released in a thin polyethylene foil as a result of elastic scattering were observed with a counter telescope and data was obtained on the neutron spectra. The spectrometer can be used for the measurement of the energy of neutrons from 2 to 20 MeV. The energy resolution capacity is, according to the energy range, 10 to 20% at a corresponding probability of 10^{-3}. The usable energy range of this spectrometer can be expanded by use of a scintillation crystal with a thickness of 3 mm up to 30 MeV. The possibility of the investigation of the energy distribution of very energetic neutrons as are produced with the large accelerators is therefore available. It is planned to use this counter telescope after completion of the isochronous synchrocyclotron for spectroscopic studies of fast neutrons with energies up to 30 MeV. (tr-auth)

4457 (MLM–1351) SEMICONDUCTOR DETECTORS CONSTRUCTION AND APPLICATIONS. Tomlinson, F. K. (Mound Lab., Miamisburg, Ohio). Sept. 22, 1967. Contract AT-33-1-GEN-53. 37p. Dep. CFSTI.

Construction and application principles of lithium-drifted silicon detectors were investigated with special emphasis on energy resolution characteristics. Silicon surface-barrier detectors were constructed to develop polishing, handling, and operational techniques applicable to the construction of lithium-drifted silicon detectors. Several surface-barrier detectors (active area, 210 mm^2) prepared for use in electron spectroscopy yielded resolutions of 10 keV (FWHM) for 625 keV electrons. A lithium-drifted silicon detector was constructed for electron and low-energy gamma spectroscopy. The resolution of the drift detector was approximately 15 keV (FWHM) for 625 keV electrons. Resolution in this range was satisfactory for resolving the K and L conversion electrons from the decay of cesium-137. The response of a 2.35 mm deep detector to cobalt-57 gamma rays resulted in a resolution of approximately 15 keV (FWHM). (auth)

4458 (NYO–3136–4) STATISTICAL ANALYSIS OF ENVIRONMENTAL AND TOTAL BODY GAMMA-RAY SCINTILLATION SPECTRA. Annual Progress Report, October 1, 1966–September 30, 1967. Pasternack, Bernard S. (New York Univ., N. Y. Inst. of Environmental Medicine). Oct. 31, 1967. Contract AT(30-1)-3136. 30p. Dep. CFSTI.

Measurements were made on four women who had been radium dial painters to determine radium body burden. The detector used was a sodium iodide crystal, and the results of four techniques of pulse-height data analysis are presented. Body content of potassium-40 was also determined. (W.H.K.)

4459 (SLAC–75) FIRST- AND SECOND-ORDER MATRIX THEORY FOR THE DESIGN OF BEAM TRANSPORT SYSTEMS AND CHARGED PARTICLE SPECTROMETERS. Brown, Karl L. (Stanford Linear Accelerator Center, Calif.). July 1967. Contract AT(04-3)-515. 109p. Dep. CFSTI.

A matrix algebra formalism is used to develop the essential principles governing the design of charged particles beam transport systems, with a particular emphasis on the design of high-energy magnetic spectrometers. (B.G.D.)

4460 (UCRL–70529) AUTOMATED LIQUID SCINTILLATION COUNTING USING A TIME-SHARED COMPUTER. Clegg, Bruce (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 27, 1967. Contract W-7405-eng-48. 7p. (CONF-671026–1). Dep. CFSTI.

From 14th Nuclear Science Symposium, Los Angeles, Calif.

The use of a time-shared computer with specially designed codes in an analytical program employing liquid-scintillation spectrometers with card, paper tape, and magnetic tape output substantially reduces the effort required to process large numbers of low-level, beta-emitting samples. Automatic data collection and use of the computer by noncomputer trained users is the emphasis of this system. Features include raw data validity checks, calculation of calibration and quench curves, total sample errors, data sorting, half-life corrections, CRT graphical output, and computer-independent input formats. The methods are generally applicable to other general purpose computers using Fortran IV whether time-shared or not. (auth)

4461 (UCRL–70544) GAMMA-RAY SPECTROMETERS FOR THE ASSAY OF COMPLEX MIXTURES OF LOW CONCENTRATION OF RADIONUCLIDES IN ENVIRONMENTAL AND BIOLOGICAL MATERIALS. Phelps, Paul L. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 24, 1967. Contract W-7405-eng-48. 19p. (CONF-671026–3). Dep. CFSTI.

From 14th Nuclear Science Symposium, Los Angeles, Calif.

Solid state detectors, especially Ge(Li) drifted diodes, have given the biologist a new and powerful tool for determining the identity of radioactive species in biological samples. Often these samples contain very low quantities of radioactivity in a complex mixture of radionuclides. High resolution, maximum counting efficiency, suppression of background and Compton radiation and enhancement of photopeaks are required. A series of gamma-ray spectrometers has been developed to assay radionuclides in biological materials. These spectrometers have incorporated features that facilitate achieving these requirements. Samples up to 8.5 cm in diameter and 2.5 cm thick are now routinely analyzed. (auth)

4462 ENERGY ANALYSIS OF CONTINUOUS X RAYS. Chiwaki, Mitsukuni. Denki Shikensho Iho, 31: 879–85(1967). (In Japanese).

Spectral distributions of filtered continuous x rays were measured with a NaI(Tl) scintillation spectrometer in x-ray tube voltage range from 40 to 180 kVp. An RCL 128 Channel Scaler Analyzer was used as the spectrometer. Gamma rays of ^{133}Ba, ^{141}Ce, and ^{203}Hg were used for calibration of the energy response and energy resolution of this spectrometer. Measured spectral distributions were corrected by using Freedmann's iteration method. The corrected spectra were compared with the spectra calculated by using Kramer's theory. The average energies of these spectra agreed with each other within ±4%. Effective energies were obtained by the absorption methods using a standard free air chamber. These values agreed with the values calculated by using Kramer's theory within ±3% except for the case of the x-ray tube voltage being 40, 60, and 80 kVp. (auth)

4463 A HIGH RESOLUTION SPECTROMETER FOR THE DETERMINATION OF EFFECTIVE DIFFERENTIAL CROSS SECTIONS IN ANGLE AND ENERGY OF SLOW ION BURST (0.5 A AND 3 keV) IN A GAS. Pernot, A.; Abignoli, M.; Barat, M.; Baudon, J.; Septier, A. (CNRS, Orsay, France). Rev. Phys. Appl., Suppl. J. Phys., 2: 203-12(Sept. 1967). (In French).

A spectrometer is described, in which ions (energy range 0.5 – 3.0 keV) scattered by atoms and molecules are analyzed versus angle, energy and mass. In this way differential cross sections (elastic or inelastic by energy analysis, rearrangement by a supplementary mass analysis) can be determined. (auth)

4464 ON THE CALCULATION OF THE SECOND-ORDER SPHERICAL ABERRATIONS OF A MAGNETIC-SECTOR ANALYZER. Basargin, Yu. G. Zh. Tekh. Fiz., 37: 1360-3(July 1967). (In Russian).

Equations of motion given by A. A. Kolomenskii and A. N. Lebedev (Teoriya tsiklicheskikh uskoriteley M., Fizmatgiz, 1962) are used to calculate the second order spherical aberrations of a magnetic spectrometer in which the magnetic field has a curved boundary and the principal trajectory lies in a plane and enters and leaves the field perpendicular to the boundary. The effect of the fringe fields is taken into account. The results are expressed in the form of corrections to be applied to the initial conditions in the integration of the equations of motion in cylindrical coordinates. It is noted that several investigators, including Hidetsugu Ikegami (Rev. Sci. Instr., 29: 943, 1948) and H. Wollnik (Nucl. Inst. and Meth., 34: 213, 1965), found only some of these correction terms. The results obtained by those authors are valid for trajectories lying in the median plane, but the additional corrections are required for other trajectories. (ATD)

4465 STABILIZED CONSTANT ACCELERATION MOESSBAUER DRIVE. Hazony, Y. (Princeton Univ., N. J.). Contract AT(30-1)-2807. Rev. Sci. Instrum., 38: 1760-3(Dec. 1967). (NYO–2807–33).

A closed feedback loop for the zero velocity drift of a constant acceleration Mössbauer spectrometer has been developed. Using a transducer with a built-in limit switch and the modified logic circuitry of a multi-scaler-analyzer, the feedback loop responds to the zero velocity drift of the entire system as a whole rather than to each component independently. A long-term zero velocity stability of ±0.001 mm/sec has been obtained. (auth)

4466 GEIGER COUNTER SPECTROMETRY OF SOFT X RAYS. Tindo, I. P. Kosm. Issled., 5: 796-7(1967). (In Russian).

A Geiger counter whose spectral sensitivity can be regulated electrically can be used for the analysis of radiation composition. The range of soft x rays depends on the wavelength, and the absorption increases monotonically (up to the K-jump) with increasing wavelength in the soft x ray region. Thus it is possible to select the composition and pressure of a gas so as to absorb the longwave x rays in a volume different from the shortwave x rays. A simple variant having two volumes was tested. An ordinary end-window oxygen counter with a beryllium window was used. A blocking positive potential of 700 volts was applied directly to the window in order to vary the efficiency of counting the longwave x rays in the absorbing volume. The measurements were carried out with the use of the fluorescent lines of magnesium (9.9 Å) and of silicon (7.1 Å). The count rate was measured with and without the application of 700 volts to the beryllium window. The modulation M which is defined as the different count rates divided by the count rate with no voltage applied to the window was found to be 23 ± 2 for the 9.9 Å radiation, 13 ± 1.5 for the 7.1 Å radiation and 2 ± 1 for ^{60}Co radiation. This simple counter can be used in space experiments to measure low-intensity soft x rays in a background of penetrating radiation. (TTT)

4467 NEUTRON VELOCITY SELECTOR. G.E.C. J. Sci. Tech., 34: 109-10(1967).

A neutron velocity selector of a novel form of construction is described. Requirements included a rotor 76 cm. long and 21 cm. diameter, encased in an evacuated steel cylinder with thin aluminium neutron windows at each end, with a rotation speed con-

tinuously variable from 300 to 3600 rpm. The equipment was for operation behind massive shielding, and accessible for maintenance once a year. A neutron transmission of 80% was required. Details are given of the design, construction, and performance of this instrument. (UK)

4468 DETERMINATION OF TRACE IMPURITIES BY NEUTRON ACTIVATION AND GAMMA SPECTROMETRY. Sterlinski, S.; Zmijewska, W. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 71-81(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

The best activation and measurement conditions for the determination of trace quantities of short-lived radioisotopes in the presence of a radioactive matrix are discussed. Results of a study of the precision of determination of As, Cu and Sb from the photopeak decay curve of a gamma spectrum is given. Methods of the determination of arsenic in pure phosphorus, cesium in sodium and potassium salts and lanthanum in high purity cerium compounds are given. Application of gamma-ray spectrometry to the analysis of high purity aluminum and the control of fused silica production process is described. (auth)

4469 THE PHOTOFABRICATION OF A RING FOCUS BAFFLE FOR A LENS β SPECTROMETER. Bennee, N. W.; Butt, D. K. (London Univ.). J. Sci. Instrum., 44: 474(June 1967).

A simple method of making a closely fitting ring focus baffle for a lens β spectrometer is described; this method allows for the presence of lens aberrations. (auth)

High Energy Physics Instrumentation

Refer also to abstract 4541.

4470 (HASL–186) RELATIVISTIC N–P SCATTERING CALCULATIONS FOR RECOIL PROTON SPECTROMETERS. Hajnal, Ferenc (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Oct. 1967. 35p. Dep. CFSTI.

Two-particle relativistic elastic scattering formulas were adapted for recoil proton spectrometry. The basic equations of the special theory of relativity are reviewed. Elastic scattering is briefly described in the cms and laboratory coordinate systems. Derivations are given for the momentum, velocity, and total and kinetic energies for the scattering and recoil particles in the cms and laboratory coordinate systems before and after scattering. The differential cross sections are then calculated after deriving the scattering and recoil angles in the cms and laboratory systems. The transformation of the physical quantities from the cms to the laboratory coordinate system is described. Empirical fitting of the differential elastic scattering cross sections in the cms system was carried out in the energy range from 27 to 630 MeV. (auth)

4471 (INR–794/VI/PH) POMIAR ROZKLADU KATOWEGO CZASTEK GENEROWANYCH W ODDZIALYWANIACH JADROWYCH ZAREJESTROWANYCH W KLISZACH. (Measurements of the Angular Distributions of Particles Generated in Nuclear Interactions Registered in Nuclear Emulsions). Coghen, T.; Czachowska, Z.; Jurak, A.; Krzywdzinski, S.; Rybicki, K.; Wolter, W. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 35p. (In Polish). Dep.

A procedure for measurement of the angular distribution of particles produced in nuclear interactions registered in nuclear emulsion is presented. Special attention was made to the measurements of small angles ($\leq$1 mr) which are present in high energy ($\geq$1 TeV) interactions. (auth)

4472 (JINR–P1-3487) SPOSOB I PROGRAMMA OPREDELENIYA PARAMETROV DLYA RASCHETA PROSTRANSTVENNYKH KOORDINAT TOCHEK TREKOV V PUZYR'KOVOI KAMERE. (The Method and Parameter Determination Program for Computing Space Coordinates of Track Points in a Bubble Chamber). Kanarek, T.; Okhimenko, L. S.; Kosareva, Z. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 16p. (In Russian). Dep.

A method for determining the parameters which characterize the scale changes in photographing the distances between particle track points was described. The parameters were used for the calculation of the space coordinates of track points in any bubble chamber. A program for the calculation of the parameters with respect to the coordinates of the datum points, measured on films by means of the UIM-21 microscope for each new exposure of the xenon of the 30-liter chamber in the particle beam, was given. (tr-auth)

4473 (JINR–P10-3526) GENERATSIYA FIKTIVNOGO TREKA. (Generation of a Fictitious Track). Makarenkova, A. D.; Moroz, V. I.; Stel'makh, A. P.; Tentyukova, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1967. 20p. (In Russian). Dep.

Adjustment and check of the programs of a geometrical reconstruction is made essentially easier if a good test material is available. With that end in view a special program for generation of test tracks of particles with different masses in the retarding medium, situated in an inhomogeneous magnetic field, was created. The account of the measurement errors and the multiple scattering is performed by the Monte-Carlo method. The track can be obtained both in the coordinate system of a track chamber and as two projections on the "left" and "right" frames of cameras in the chamber. (auth)

4474 (ORO–2504-110) A VIDICON SYSTEM FOR BUBBLE COUNTING AND TRACK MEASURING. Technical Report No. 730. Day, Donald Keith (Maryland Univ., College Park. Dept. of Physics and Astronomy). 1967. 38p. Dep. CFSTI.

A video picture of a 1 cm by 0.44 cm section of a bubble chamber photograph projected on a scanning table is digitized and recorded on magnetic tape as 9216 bits, along with data from an up-down scaler which gives the coordinates of the picture taken as 36 bits. Also available are 36 binary bits for recording auxiliary information. The digitized information may then be reduced by a high-speed computer to provide useful data such as precise track coordinates and bubble densities or gap length distributions. The track coordinates are used in the analysis of bubble chamber events. The gap length distribution can be used to distinguish between particles of different mass whose tracks have about equal curvatures in the magnetic field of the bubble chamber. (auth)

4475 (PPAD–628E) AUTOMATIC PATTERN RECOGNITION AND EVENT MEASUREMENT ON BUBBLE CHAMBER PHOTOGRAPHS WITH A MODIFIED PEPR-TYPE MACHINE. Sekely, M. E. (Princeton Univ., N. J. Palmer Physical Lab.). July 26, 1967. Contract AT(30-1)-2137. 42p. Dep. CFSTI.

An attempt was made to balance and minimize the measurement precision requirements in coordinates and angles for a PEPR type machine for the purposes of practical pattern recognition and adequately accurate track parameter computations. The systems analysis showed the superiority of the tangent method over the point processing methods both for accuracy (by using analytical error estimates, thus avoiding the pitfalls of computer-simulation procedures) and for the volume of necessary computations and gave closed-loop algorithms for pattern recognition and a very fast spatial reconstruction scheme which bypasses the Thresh routine and furnishes complete track parameters and errors usable for an on-line kinematic check of the recognized patterns. It promises to achieve the sole purpose of our effort—faster and cheaper data processing. To compute angles and momenta to the required maximum 10 bit precision, data measured with 12 bit precision are adequate if one uses the given algorithms and a new method to correct for optical distortion. The calculations can be executed in fixed point single precision mode with the PDP-7 used for scanning and pattern recognition. The scanning machine is under construction and it could be put into production in about one year if programming is started immediately. (auth)

4476 (UR–875–219) SIMULATION OF IMAGE–PLANE–DIGITIZER MEASUREMENTS. Yuta, H.; Ferbel, T.; Berlinghieri, J. C. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). Oct. 24, 1967. Contract AT(30-1)-875. 11p. Dep. CFSTI.

Image-Plane Digitizers (IPD) are used for measuring high-energy bubble chamber interactions. IPD data are simulated to determine whether IPD's can be used successfully at energies above 7 GeV/c and particularly at 13 GeV/c. The methods of simulation, results, and conclusions are presented. (W.H.K.)

4477 STUDIES OF ELEMENTARY COMPOSITION OF NUCLEAR EMULSIONS. Bogomolov, K. S.; Vakhtanova, L. P. (All-Union Scientific-Research Cinema-Photographic Inst., Moscow). Zh. Nauch. Prikl. Fotogr. Kinemotogr., 12: 349-52 (Sept.-Oct. 1967). (In Russian).

The elementary composition of nuclear emulsions treated in relative air humidity of 58% was investigated. The basic characteristics of the BR NIKFI, BK NIKFI, and G-5 Ilford emulsions are tabulated and evaluated. (R.V.J.)

4478 LARGE AREA TIME-OF-FLIGHT COUNTER SYSTEM. Stefanski, R. J. (Yale Univ., New Haven); Adair, R. K.; Kasha, H.; Larsen, R. C. Rev. Sci. Instrum., 38: 1792-3(Dec. 1967). (BNL–11845).

The design and performance of an isochronous detection system for time-of-flight measurements of elementary particles with large-area scintillation detectors are presented. The isochronous detection system is designed with the scintillator in the focal plane of a parabolic mirror and a photomultiplier tube at the focus of the mirror. (W.H.K.)

4479 USE OF IMAGE INTENSIFIERS WITH STREAMER CHAMBERS. Jones, Lawrence W.; Loo, Billy W. (Univ. of Michigan, Ann Arbor). Advan. Electron. Electron Phys., 22B: 813-22(1966).

From Third Symposium on Photo-Electronic Image Devices, London, Sept. 20–24, 1965. See CONF-650991.

The experimental arrangement and performance of image intensifiers for recording particle tracks in streamer chambers are described. (W.H.K.)

4480 MAGNETOSTRICTIVE READOUT FOR WIRE SPARK CHAMBERS. Perez-Mendez, Victor; Pfab, J. M. (to U. S. Atomic Energy Commission). U. S. Patent 3,359,421. Dec. 19, 1967.

Spark detection methods for very large wire chambers are described. A separate magnetostrictive nickel ribbon is disposed proximal to each wire plane of the chamber whereby the spark current fields are magnetically coupled to the ribbon, causing local deformations which travel therealong for detection upon arrival at a pick-up coil. The spark positions are determined and digitized in logic circuitry from the energy dissipation and travel time of the deformation pulse along the ribbons. (AEC)

4481 VARIABLE RADIATION LENGTH BUBBLE CHAMBER. Goldhaber, M. (to U. S. Atomic Energy Commission). U. S. Patent 3,358,144. Dec. 12, 1967.

A bubble chamber of variable radiation length for the detection and tracking of ionized particles is described. The bubble chamber employs variable mixtures of hydrogen and neon to obtain the desired characteristics within the chamber. (AEC)

Radiation Dosimeters

4482 (BNWL-SA-1364) PROPORTIONAL COUNTER FOR SPACE AND HIGH ALTITUDE DOSIMETRY APPLICATIONS. Endres, G. W. R.; Glass, W. A.; Haverfield, A. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 9, 1967. Contract AT(45-1)-1830. 10p. (CONF-671026-2). Dep. CFSTI.

From 14th Nuclear Science Symposium, Los Angeles, Calif.

The design and performance of spherical tissue-equivalent proportional detectors for measuring the absorbed dose of gamma radiation and neutrons are presented. Dose distribution and LET data are included. (W.H.K.)

4483 (CERN-67-28) FORTRAN PROGRAMMES FOR THE TREATMENT OF PERSONNEL MONITORING DATA. Dutrannois, J.; Koelbig, K. S. (European Organization for Nuclear Research, Geneva (Switzerland)). Sept. 29, 1967. 44p. Dep.

Two computer programs for interpreting personnel monitoring data recorded on personal film-badges at CERN are described. They are written in FORTRAN and used in the CDC 6600 computer. (W.H.K.)

4484 (NP-17062) ETALONNAGE DE QUELQUES DETECTEURS PORTATIFS USUELS POUR LES MESURES DE DOSES β, PAR COMPARAISON AVEC UNE CHAMBRE A EXTRAPOLATION. (Calibration of Certain Portable Detectors for Measuring β Doses by Comparison with an Extrapolation Chamber). de Choudens, H. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [June 28, 1965]. 19p. (In French). Dep.

The calibration of portable β dose detectors by comparison with an extrapolation chamber is described. The principle and the construction of an extrapolation chamber are discussed. Measurements were made to determine the correction factors for some portable devices. These measurements showed that all the commercial devices tested have very significant errors when the β doses are measured for sources placed in contact or very near the detectors. It was concluded that all β measurements should be made with a device especially designed for β measurement or with a detector calibrated with an extrapolation chamber or a similar device. (J.S.R.)

4485 CONTINUOUS DOSIMETRIC APPARATUS FOR RADIATION CATALYSIS. Spitsyn, Vikt. I.; Mikhailenko, I. E.; Glazunov, P. Ya.; Voronin, Yu. V.; Parfanovich, B. N. (Inst. of Physical Chemistry, Moscow). Kinet. Kataliz, 8: 946-8(July-Aug. 1967). (In Russian).

A radiation-catalytic device with continuous dosimetry and with remote control was constructed. The device was designed for carrying out heterogeneous catalytic reactions under a beam of accelerated electrons and over radioactive catalysts. (tr-auth)

4486 THERMOLUMINESCENT DOSIMETER ON LITHIUM FLUORIDE BASIS. Grube, M. M.; Mezhs, T. K.; Grant, Z. A.; Shvarts, K. K. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. inat. Ser., No. 4, 55-8(1967). (In Russian).

A LiF thermoluminescent system for dosimetry of γ- and x-rays, charged particles, and thermal neutrons was developed. The phosphor was investigated in terms of radiation dosimetry and was found to have a linear response ranging from 0.1 rad to 10^4 rad with an information loss of less than 15 percent per month. The phosphor can be re-used without having changed its sensitivity. Numerous applications of thermoluminescence dosimetry in personnel monitoring, radiology and radiobiology were described. (auth)

4487 GAMMA-RAY DOSIMETRY WITH POLYVINYL FLUORIDE. Windley, W. C.; Elleman, T. S. (North Carolina State Univ., Raleigh). J. Nucl. Energy, 21: 803-8(Oct. 1967).

An investigation of polyvinylfluoride plastic film as a possible radiation dosimeter was carried out. Important characteristics of the film are listed. Samples of 4 mil film were irradiated using a ^{60}Co source. Optical density was measured after 8 hr to allow for initial fading on a recording spectrophotometer. A major absorption peak was found at 315 mμ, with other peaks at 303 mμ, 352 mμ, and 386 mμ. Optical density varied linearly with absorbed dose for each absorption peak. Calculated extinction coefficients were 5.6×10^{-6} rad^{-1}cm^{-1} for samples irradiated in He, and 3.2×10^{-6} rad^{-1}cm^{-1} in air. Moisture had only a slight effect. Extinction coefficients of a number of plastics are compared, and attention is drawn to the advantages of polyvinylfluoride. (UK)

4488 PERSONAL RADIATION ALARM DOSIMETER. Tanaka, Eiichi (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys., 13: 1337-46(Dec. 1967).

A personal alarm dosimeter for x and γ rays based on a new principle of charge detection was developed. Ion current of an ionization chamber is accumulated on a vibrating capacitor, whose output is fed to its driving coil through an ac amplifier so that, if the charge on the capacitor exceeds a certain amount, the system produces howling oscillation, a part of the oscillation signal being amplified to provide audible alarm and visible indication. The prototype instrument is all transistorized and encapsuled in an aluminum case of $21 \times 26 \times 155$ mm. The weight is about 110 g. The alarm level is adjustable in the range $0 \sim 20$ mR, and the dose accumulated is readable by simple procedure at any desired time. The natural leakage is about 0.8 mR per 24 hr. The power is supplied from a 15 V battery, and the current consumption is about 0.4 mA in quiescent state ($1 \sim 1.2$ mA during oscillation) at 20°C. (auth)

4489 NEUTRON DOSE CALIBRATION BY A LOW POWER REACTOR. Nishiwaki, Yasushi (Tokyo Inst. of Tech.); Shimizu, Hidebumi Hoken Butsuri, 1: No. 2, 49-54(Dec. 1966). (In Japanese).

A few methods for neutron dose measurements were examined. A simple method for dose calibration by a low power reactor is introduced. Calibration with the theoretically calculated values of some neutron dosimeters was made. This calibration was based upon the neutron flux values estimated by the activation method using the neutron field of UTR-B operating at 0.1W. On the calibration with the Bendix fast neutron dosimeter and thermal neutron dosimeters, the experimental values were found to be close enough to the theoretical values to be of practical use from the operational health physics standpoint. (auth) (NSA of Japan)

Radiometric Instruments

Refer also to abstracts 4270, 4273, and 4313.

4490 RADIOACTIVE TRACER ABLATION SENSOR. Bartley, John D. Jr. (Emerson Electric Co., St. Louis); Beisher, Richard; Jacobi, Thomas. Trans. Amer. Nucl. Soc., 10: 456 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4491 METAL THICKNESS GAUGE USING ^{241}Am AS THE RADIATION SOURCE: ITS PERFORMANCE AND EXAMPLES. Miwa, Hirohide; Mizukoshi, Makoto (Kobe Kogyo Corp., Japan). Genshiryoku Kogyo, 12: No. 10, 67-71(Oct. 1966). (In Japanese).

The accurate measurement of metal thicknesses by X-rays in the

process of manufacturing is complicated and expensive, and the non-contact measurement of iron sheets up to 5 mm thickness, with a radiation source, has long been a problem. A versatile and simple thickness-gage, using a 60 keV γ-emitter ^{241}Am with a half-life of 480 years was developed. The gage consists of a C-type frame containing an ionization chamber and a 300 mCi source; a mechanism for moving the C-frame manually and electrically; and a dc amplifier with a negative feed-back circuit, for detecting the difference of thickness of a specimen from the standard. The temperature dependence of the ionization chamber used in the gage is only $1.4 \times 10^{-3}\%/°C$. The results of thickness measurements for variety of experimentally prepared iron sheets were in good agreement with those by the industrial flying micrometer and the micrometer technique. (NSA of JAPAN)

4492 IGNITION NOISE IN NEUTRON MOISTURE GAGES. Stone, John F.; Barefoot, A. Dudley; Garton, James E. J. Irrig. Drain. Div., Amer. Soc. Civil Eng., 93: 147-52 (Sept. 1967).

Studies were conducted on the manner and variability of noise experienced in neutron moisture gages as produced by the ignition of nearly reciprocating engines. The probe units tested had a Ra : Be neutron source, a 1-in. dia BF_3 slow-neutron detector tube, and a preamplifier using transistors. It was found that spark-fired engines couple spurious counts into these neutron moisture gages. Electromagnetic coupling to the cable connecting the probe unit and counter unit seemed to be the cause. Pulses were apparently amplified in the probe unit and duly recorded to the counting unit. Interference was not noted in cases where the cable was positioned no closer than 3 ft from any portion of the motor vehicle. If moisture measurements are to be made in the vicinity of operating spark-fired engines, a test for interference should be made. (BBB)

4493 USE OF ISOTOPES AS SENSING ELEMENTS FOR THE AUTOMATION OF MEASURING OF WEIGHED MATERIALS. Kaluta, Romuald; Pruski, Andrzej. Pomiary Automat. Kontr., No. 1, 23-6(1967). (In Polish).

The principal methods of utilizing radioactive isotopes as sensing elements in semiautomated or automated balances are discussed and the use of Soviet TsTTs-5 strontium-90 and Geiger–Mueller counters in developing sensing systems for measuring one or more components is described. The development was carried out in cooperation with the Lubelski Balance Plant, Lublin (Lubelski Fabryki Wag), and instruments produced were installed on industrial type balances manufactured by this plant. The use of automated weighing equipment, particularly in concrete production, and the economic advantages of the method are discussed. (JPRS)

4494 RADIOMETRIC METHODS OF INDUSTRIAL CHEMICAL ANALYSIS INVESTIGATED IN THE INSTITUTE OF RADIOISOTOPE TECHNIQUES AGH IN KRAKOW. Florkowski, T.; Gorski, L. (Inst. of Nuclear Tech., Krakow. Academy of Mining and Metallurgy, Krakow). Nukleonika, 10: Suppl., 59-69 (1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10–12, 1964. See CONF-640210.

Several radiometric methods of the industrial chemical analysis with isotope x-ray sources, beta sources, and neutron sources are presented. The preferential absorption of x rays and excitation of characteristic x rays in the measured sample is used for the determination of lead, zinc, iron and copper in ores, chlorine in solutions, tungsten in steel, and sulphur in hydrocarbons. Beta backscattering technique is used for the determination of lead content in lead-zinc concentrates. The copper content in ores can be also measured using activation analysis with fast neutrons from neutron generator. The cadmium determination during the technological process in a wide range of cadmium content is based on the absorption of slow neutrons. (auth)

4495 IMPROVED THICKNESS MEASURING GAUGE. Cooper, Brian Sidney; Westwood, Walter. (to Johnson, Matthey and Co., Ltd.). British Patent 1,091,468. Nov. 15, 1967. Filed Feb. 11, 1965.

The design of a beta-backscatter thickness gage for determining the thickness of metallic layers is presented. Components include a beta source, a scintillation screen, a photomultiplier, and an electronic timing and scaling device. (W.H.K.)

4496 ICE-WARNING INDICATOR. Emelyanov, Slava Stanislavovich; Polischuk, Konstantin Efimovich; Dmitriev, Michail Vasilievich; Rogachev, Vladimir Ivanovich (to Vsesoiuzny Nauchno-Issledovatelsky Institut Radiatsionnoi Tekhniki). British Patent 1,090,920. Nov. 15, 1967. Filed Nov. 3, 1965.

Specifications for an ice-warning indicator for use on aircraft are presented. The apparatus is composed of a beta-emitter and a detection system with a collector between the emitter and detector for ice formation. When ice forms on the collector, the beta flux is reduced and the system is activated. A heater is installed to de-ice the collector for intermittent monitoring. (W.H.K.)

4497 METHOD AND APPARATUS FOR TESTING HOLLOW ARTICLES. (to Ball Brothers Research Corp.). British Patent 1,090,912. Nov. 15, 1967. Priority date Jan. 23, 1964, United States.

The design of a gage for measuring the wall thickness of hollow articles by radiation absorption is presented. Complete specifications are included. (W.H.K.)

Miscellaneous Instruments and Components

Refer also to abstracts 4662, 5317, and 5641.

4498 (APDA-210) DEVELOPMENT OF THE UNDER-SODIUM ULTRASONIC SCANNER. Scott, C. C.; Ying, Shuh-Pan (Atomic Power Development Associates, Inc., Detroit, Mich.). Oct. 1967. Contract AT(11-1)-865. 86p. Dep. CFSTI.

A scanning system that employs a focusing transducer for producing a single narrow ultrasonic beam for locating and discerning objects in high-temperature opaque media, such as 600 F liquid sodium, has been developed. The feasibility studies that preceded development of the system and the developmental work involving acoustic parameters, design and analysis of the mechanism, experimental results, and practical demonstrations are discussed. The focusing transducers were operated at frequencies of 2.25 and 5 Mc/sec with lead zirconate–titanate piezoelectric ceramic disks at distances from $\frac{1}{4}$ inch to approximately 3 feet from the targets. The zirconium planospherical lenses of the focusing transducers not only provided single focusing points but also, suppressed side lobes radiated from the transducers at distances far beyond the focal points. The direction and the range of a target were read from the orientation of the transducer and the cathode ray oscilloscope, respectively. For display of images of targets, a current-sensitive helix wire recorder was used. The scanner resolution for both distance and orientation was found satisfactory. (auth)

4499 (BARC-290) SETTING UP OF A RECORDING FABRY-PEROT SPECTROMETER (REFPOS). Saksena, G. D.; Ahmad, S. A. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 21p. Dep.

The fabrication and performance of the Recording Fabry–Perot Spectrometer for investigating the structure of individual spectral lines at very high resolution and for isotope abundance determination of elements are presented. The instrument consists of a monochromator assembly, Fabry–Perot interferometer assembly, and photomultiplier and recorder assembly. (W.H.K.)

4500 (JINR-P15-3504) PRIMENENIE POLYARIMETRA S KOLTSEVYM ANALIZATOROM DLYA ISSLEDOVANIYA POLYARIZATSII PROTONOV IZ YADERNYKH REAKTSII. (Application of Polarimeter with Annular Analyzer for Investigation of Proton Polarization from Nuclear Reactions). Krivopustov, M. I.; Sizov, I. V.; Shirmer, G.; Eler, G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1967. 55p. (In Russian). Dep.

The annular geometry for measurements of the polarization of nuclear reaction products is described. Data on the angular and energy dependence of proton polarization from the reaction of ^3He with carbon are given. (auth)

4501 (K-DP-2593) COUNTING SCHEMES FOR NUCLEAR DATA ACQUISITION ON SMALL COMPUTERS. Rust, Bert W.; Burrus, Walter R. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). [1967]. Contract W-7405-eng-26. 15p. (CONF-671026-4). Dep. CFSTI.

From 14th Nuclear Science Symposium, Los Angeles, Calif.

In using a small computer for accumulating a pulse height spectrum, it is often the case that the word length is too small to store the counts on a one-word-per-channel basis. The use of double precision to avoid this problem is wasteful of storage space. One way to avoid this waste is to store the differences between counts in two adjacent channels rather than the counts themselves. Another method involves the use of a stochastic counting scheme for accumulating the spectrum. These methods are presented and discussed. (auth)

4502 (KAPL-3352) FABRICATION OF 18-STAGE ELECTRON MULTIPLIER. Dietz, L. A.; Hanrahan, L. R.; Hance, A. B. (Knolls Atomic Power Lab., Schenectady, N. Y.). June 14, 1967. Contract W-31-109-eng-52. 24p. Dep. CFSTI.

The construction of a fast, high-gain electron multiplier suitable for pulse-counting of single positive or negative ions or neutral atoms in a mass spectrometer is given in detail. Special attention to the preparation of the target surface, which converts ions to electrons, and to the interdynode focusing of the secondary electrons, results in high detection efficiency and low background counting noise. Preparation of the Al_2O_3 thin-film target surface is described, along with a high-temperature vacuum oven used to oxidize the BeCu dynodes of the electron multiplying stages. (auth)

4503 (LA-DC-8841) ON-LINE APPLICATION OF ELECTRONIC CALCULATORS TO NUCLEAR COUNTING SYSTEMS. Fullbright III, Henry J. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 13p. (CONF-671026-9). Dep. CFSTI.

From 14th Nuclear Science Symposium, Los Angeles, Calif.

The design, operation, and applications of programmable electronic desk calculators capable of direct connection to existing nuclear counting systems used in the nondestructive testing program at LASL are discussed. (B.G.D.)

4504 (MLM-290) WEIGHING RADIOACTIVE MATERIALS BY MEANS OF A VACUUM MICROBALANCE. Final Report. Morgan, H. C. (Mound Lab., Miamisburg, Ohio). Mar. 7, 1949. Contract AT-33-1-GEN-53. 15p. DTIE.

The design and use of an Ainsworth microbalance under vacuum and shielded from heat radiations for weighing radioactive materials are presented. Experimental work and calculations on the weighing of metallic polonium are included. (W.H.K.)

4505 (ORNL-TM-1638(Pt.7)) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 7. SERVO DEMAND DRIVE UNIT, ORNL MODEL Q-2607. Anderson, J. L. (Oak Ridge National Lab., Tenn.). Nov. 9, 1967. Contract W-7405-eng-26. 13p. Dep. CFSTI.

The circuit, applications, maintenance procedures, and acceptance tests for a Servo Demand Drive Unit are described. The unit consists of a motor-driven, precision potentiometer assembly and adjustable rotary limit switches. Accurate external reference voltages are applied across the potentiometer sections, and the demand signals are taken from the wipers of the potentiometers. The drive motor is actuated through remote switching from a source of 32 V dc. (auth)

4506 VORTEX-SCHEME PLASMATRON FOR HIGH-CURRENT OPERATION. Dautov, G. Yu.; Dudnikov, Yu. S.; Zhukov, M. F.; Sazonov, M. I. (Inst. of Theoretical and Applied Mechanics, Novosibirsk, USSR). Teplofiz. Vys. Temp., 5: 500-4(May-June 1967). (In Russian).

A high-current plasmatron has been built and tested. Volt-ampere and thermal characteristics were obtained using argon gas which yields a low thermal efficiency. A flow-rate ratio of $G_2/(G_1 + G_2) = 0.77$ to 0.80 was used. Volt-ampere characteristics are plotted and oscillograms taken of the voltage and current are shown. Arc shunting is observed and has a frequency of about 2 kHz. Thermal efficiency η and related data are tabulated, η ranging from 0.4 to 0.5. Extreme cooling was required for operation of the plasmatron. Accumulation of vaporized copper from the electrodes onto the window at the back of the chamber resulted in a slight reverse flow of the plasma. Photos of the radial portion of the arc are shown for various regions of operation. (ATD)

4507 TWO-BEAM VACUUM MONOCHROMATOR DVM-1 WITH COMPENSATING RECORDING SYSTEM. Tiit, V. M. (Inst. of Physics and Astronomy, Tartu). Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 7: 278-83(Aug. 1967). (In Russian).

An apparatus designed for investigation of the radiation collector (photon counters, ionization chambers, etc.) which can be used in the spectral interval from 10 to 22 Å is described. It consists of the two-beam vacuum monochromator DVM-1 and a series of electronic blocks using hydrogen tubes and radiation collectors for feed and for signal recording and system control. The separate devices automatically eliminate the effect of the variation of the intensity of the output of the light beams. Some experimental results characterizing the operation of the monochromator and its recording system, are reported. (tr-auth)

4508 RESPONSE OF FERMI FUEL SUBASSEMBLY OUTLET THERMOCOUPLES UNDER NORMAL AND FUEL-FAILURE CONDITIONS. Callen, R. C. (Atomic Power Development Associates, Inc., Detroit); Prouteau, L. P.; Friedland, A. J. Trans. Amer. Nucl. Soc., 10: 637-8(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4509 MICROWAVE TECHNIQUES FOR REACTOR INSTRUMENTATION. Billeter, T. R.; Brown, D. P. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 637(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4510 NEUTRONICS INSTRUMENTATION FOR ROVER REACTORS. Perry, R. T. Jr.; McFerrin, D. N. (Edgerton, Germeshausen and Grier, Las Vegas, Nev.). Trans. Amer. Nucl. Soc., 10: 641-2(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4511 MAGNETIC-SIGNALED AUTOMATIC FUEL-SURVEILLANCE SYSTEM. Lawroski, Harry; Hutton, Jack E.; Curran, Robert N. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 10: 639-40(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4512 USE OF THE DOUBLE-CRYSTAL DIFFRACTOMETER. Berman, Robert M. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 504(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4513 PULSE HEIGHT ANALYSIS AND 400-CHANNEL ANALYZER. Nishiwaki, Koji; Matsushita, Hajimu (Hitachi Ltd., Tokyo). Hitachi Hyoron, 16: No. 7, 295-303(June 1967). (In English).

The Model RAH-403 400-channel analyzer, which performs the versatile functions of pulse-height analysis, multiscaling, time-of-flight measurement, signal averaging analysis, etc., by interchanging the input converter unit, has been designed for a wide range of analytical uses through transistorization for compact construction and adoption of a plug-in system. The mechanism of single-input and multi-input analysis of pulse height are described, as well as a few instances of analysis. It consists of six functional units for input amplification, A-D conversion, control, memory, read-out, and power supply. The equipment offers functions for multiple uses and is particularly useful for analysis of nuclear radiation by means of a scintillation detector. (NSA of JAPAN)

4514 RECENT DEVELOPMENT OF ANALYTICAL INSTRUMENTS USING RADIATION. Fukao, Yoshiro; Miyoshi, Katsuhiko (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rev., Int. Ed., 22: No. 5, 582-91(May 1967). (In Japanese).

The analytical instrument DIFFPET has unique features such as simple and compact construction and versatile functions with respect to x-ray diffraction. The neutron-activation analysis unit ACTIVAC has also conspicuous merits as a tool for rapid and nondestructive determination of oxygen. (auth)

4515 CHANNEL SELECTOR FOR A SINGLE-CHANNEL PULSE-HEIGHT ANALYZER. Johnson, Ralph A. (Shell Development Co., Emeryville, Calif.); Blair, Donald C. Anal. Chem., 39: 1899-1900(Dec. 1967).

A selector for choosing any one of a number of preset channels of a single-channel pulse-height analyzer is described. This channel selector provides better reproducibility of the window settings and greater speed and convenience in making the settings. (W.H.K.)

4516 THREE-DIMENSIONALLY ROTATING SAMPLE HOLDER FOR 14-MILLION ELECTRON VOLT NEUTRON IRRADIATIONS. Dyer, F. F.; Bate, L. C.; Strain, J. E. (Oak Ridge National Lab., Tenn.). Anal. Chem., 39: 1907-9(Dec. 1967). (ORNL-P-3257).

The design and performance of a sample holder for 14-MeV neutron irradiations are presented. The sample holder rotates three-dimensionally to obtain uniform irradiation of the sample and thus minimize errors in activation analyses. (W.H.K.)

4517 TEMPERATURE CONTROLLER FOR THERMOLUMINESCENCE STUDIES. Wolf, Robert A.; Bowser, Merle L. (Bureau of Mines, Pittsburgh). Rev. Sci. Instrum., 38: 1806-7(Dec. 1967).

The design of a constant heating rate apparatus for thermoluminescent studies is described. The unit controls the heating of mineral specimens so that the temperature rises at a constant rate from 25 to 600°C. The rate of heating can be varied from about 9 C°/min to 9 C°/sec. (auth)

4518 AGING AND REJUVENATION OF ELECTRON MULTIPLIERS. Wright, W. H. (Southwest Center for Advanced Studies, Dallas). Contract NAS5-9112. Rev. Sci. Instrum., 38: 1802-3(Dec. 1967).

Exposure of electron multipliers to the atmosphere causes a decrease in the gain of the multiplier. Efficiency data for multipliers aged in the atmosphere and then rejuvenated by outgassing and baking in an oxygen atmosphere are presented. (W.H.K.)

4519 INTEGRATOR FOR NANOSECOND PULSES. Anderson, R. L.; Porat, D. I. (Stanford Linear Accelerator Center, Calif.). Contract AT(04-3)-515. Rev. Sci. Instrum., 38: 1800-2(Dec. 1967). (SLAC-PUB-286).

Design of a nanosecond pulse integrator for photomultiplier pulse-height analyzers is presented. Two integrating circuits are used to determine the rise and fall times of the output pulse. (W.H.K.)

4520 NANOSECOND LIGHT SOURCE, XP-20. Johnson, J.; Porat, D. (Stanford Linear Accelerator Center, Calif.). Contract AT(04-3)-515. Rev. Sci. Instrum., 38: 1796-8(Dec. 1967). (SLAC-PUB-308).

The characteristics of the XP-20 miniature gallium-phosphide diode were measured; it was found suitable as a nanosecond light source in counter techniques, such as testing of fast photomultipliers and hodoscope arrays in high-energy physics applications. (auth)

4521 CLASS OF WAVEGUIDES WITH UNIFORM ELECTRIC FIELD STRENGTH. Harp, R. S.; Moser, R. M. (Stanford Univ., Calif.). Rev. Sci. Instrum., 38: 1795-6(Dec. 1967).

A class of waveguides operating in the TE_{10} mode which have substantially uniform electric fields over the waveguide cross section is described. (W.H.K.)

4522 HELIUM VAPOR COOLED CURRENT LEADS. Efferson, K. R. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Rev. Sci. Instrum., 38: 1776-9(Dec. 1967). (ORNL-P-3236).

A new technique is described for constructing vapor-cooled leads used to introduce electrical currents into liquid helium. Using this method, leads can be constructed to carry optimum currents ranging from low values (less than 100 A) to very high values (several thousand amperes). The current carrying elements are small (No. 38) silver-plated copper wires woven into the shape of cylindrical tubes (i.e., electrostatic shielding). This fine division of the current-carrying elements allows very good heat exchange with the helium boil-off gas. Helium losses are approximately 2.71×10^{-3} liter/h A for a pair of leads operating at the optimum current. (auth)

4523 MAGNETIC MEASUREMENTS UNDER HYDROSTATIC PRESSURE: INTENSITY OF MAGNETIZATION AND ANISOTROPY. Kawai, N.; Sawaoka, A. (Osaka Univ). Rev. Sci. Instrum., 38: 1770-2(Dec. 1967).

A new technique was developed to make magnetic observations of weakly magnetized materials under hydrostatic pressure up to 12 kilobars in a wide temperature range from liquid-helium temperature up to 200°C. We have designed a special type of nonmagnetic pressure vessel in which the materials to be measured were pressurized. For measuring magnetization, the above pressure vessel was connected to a torsion pendulum and its deflection in a magnetic field was measured. For measuring the anisotropy of ferromagnetic crystals, the vessel was connected to an air-jet supported magnetometer having an unbonded strain-gauge detector and its torque moment in a uniform magnetic field was determined. (auth)

4524 SYSTEM FOR CONTINUOUS RECORDING OF CRITICAL CURRENT CURVES OF SUPERCONDUCTORS. Shaw, R. W.; Laquer, H. L. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Rev. Sci. Instrum., 38: 1768-9(Dec. 1967). (LA-DC-8934).

A method is described which allows the direct and continuous recording of the critical current versus magnetic field curves for superconductors. The system uses an electronic integrator to control a current supply so as to produce a selected small voltage across the sample. It presents an improvement in both speed and ease of obtaining critical current curves. (auth)

4525 USE OF PURE COPPER AS A STANDARD SUBSTANCE FOR LOW TEMPERATURE CALORIMETRY. Martin, Douglas L. (National Research Council of Canada, Ottawa). Rev. Sci. Instrum., 38: 1738-40(Dec. 1967).

Measurements in the temperature range 0.4 to 3°K have shown that the specific heat of American Smelting and Refining Co. 99.999+% pure copper in the "as received" condition may be higher than the specific heat of samples which have been vacuum annealed or vacuum cast from this material, possibly due to the presence of a dissolved gas. The specific heat of copper has been increased (by a percent or so) by heating in a hydrogen atmosphere. The effect of very low levels of transition metal impurities on the specific heat is discussed. (auth)

4526 RESONANCE RELAXATION SOUNDER FOR THE MULTIPLE IONOSPHERIC PROBE. Hugill, J.; Field, M. J. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Rev. Sci. Instrum., 38: 1731-5(Dec. 1967).

Design parameter selection, block diagram, special circuit description, and calibration procedure are given for rocket instrumentation used to measure plasma resonances in the E-region. (auth)

4527 MEASUREMENT OF TORQUES AT LOW TEMPERATURES. Metz, Claire D. (City Univ. of New York, N. Y.). Rev. Sci. Instrum., 38: 1723-5(Dec. 1967).

A method is described for producing calibrated torques at low temperatures using the interaction between an applied magnetic field and a superconducting torus. The torque produced is proportional to the square of the applied magnetic field and can thus be varied continuously over a wide range by varying the current which produces the magnetic field. It can be used in a null method to measure any torques of interest, such as the torques produced by second sound on a Rayleigh disk or on a radiation balance. The principal advantages of this method are that a wider range of torques is available with a given assembly and that the null position is more easily obtained. (auth)

4528 BROADBAND NUCLEAR RESONANCE DISPERSION DETECTOR. Blume, R. J.; Edmonds, D. T. (Yale Univ., New Haven). Rev. Sci. Instrum., 38: 1716-19(Dec. 1967).

The detector is a Robinson limited oscillator with a single tuning control to which has been added an untuned "transmitter" coil orthogonal to the usual sample coil. Oscillation is maintained by a combination of Robinson feedback and weak mutual coupling of the two coils. The rf fields of the two coils are in time phase; the transmitter field is much the stronger. Dispersion signals were obtained in tests to 20 MHz at least as easily as were absorption signals with a conventional autodyne. The circuit is especially well suited to frequency-swept searches for narrow, easily saturable lines (since the dispersion signal does not saturate) and those requiring high H_1 with unimpaired sensitivity (since the "receiver" sees the entire nuclear signal, but only a small fraction of the "transmitter" output). (auth)

4529 RESPONSE OF ION-SENSITIVE PLATES AS A FUNCTION OF ION ENERGY. Woolston, J. R.; Honig, R. E.; Botnick, E. M. (RCA Labs., Princeton, N. J.). Contract AF 19(628)-5106. Rev. Sci. Instrum., 38: 1708-13(Dec. 1967).

To attempt a better understanding of the mechanism of ion detection with ion-sensitive plates, a study was made of sensitivity as a function of ion energy, and of blackening as a function of exposure. Various commercially available and experimental plates used in mass spectrography were investigated. A dc beam of Cs^+ ions was used to expose evenly areas 0.1 by 0.25 cm on the plates, which were placed between the ion beam monitor collector and the magnetic sector entrance boundary of an AEI type MS7 double-focusing mass spectrograph. Thus, after leaving the ion source, the ions traversed only the electrostatic sector portion of the instrument. For the sensitivity study, exposures were made with ion energies ranging from 0.1 to 20 keV on Ilford Q2, Kodak SWR, Kodak-Pathé SC5, and RCA thin-film plates made by the direct evaporation of AgBr onto glass. In addition, blackening as a function of exposure was determined at various energies for each ion-sensitive material. The relation observed between sensitivity and ion energy, when plotted in double-logarithmic fashion, is not a simple linear function but exhibits a complex behavior. (auth)

4530 GELATIN-FREE ION-SENSITIVE PLATES FOR MASS SPECTROGRAPHY. Honig, R. E.; Woolston, J. R.; Kramer, D. A. (RCA Labs., Princeton, N. J.). Contract AF 19(628)-5106. Rev. Sci. Instrum., 38: 1703-7(Dec. 1967).

Several methods have been explored to produce gelatin-free thin-film plates of superior performance for the detection of positive ions. Of these methods, vacuum deposition of silver halides has been found to be the most flexible system and has been examined in an extended series of tests. Particle size, sensitivity, and shape of the response curve were studied as a function of various experimental parameters, such as evaporation temperature, thickness of layer, substrate temperature, ion energy, developing conditions, and others. The plates obtained by this technique have particle sizes of about 1 μ and yield sensitivities, for 20 keV ions, approaching those of Ilford Q2 plates at 50% blackening. When blackening B is plotted vs log E (E = exposure in coulombs), the slope of the resulting response curve is considerably steeper than that found for Q2 plates. The thin-film plates produced have a number of advantages over the

commercially available Schumann-type plates: the background blackening of unexposed areas approaches that of clear glass and has an unusually low noise level; spectral line sharpness is greatly improved; the plates show practically no halation, have good conductivity and excellent vacuum properties; and there are no storage problems. (auth)

4531 VOLTAGE-SENSING DEVICE FOR MONITORING X RAYS. Pipes, E. W. (Union Carbide Corp., Oak Ridge, Tenn.). Contract W-7405-eng-26. Health Phys., 13: 1351-2 (Dec. 1967). (Y-IA-40).

A safety device was constructed which can be used to determine if an x-ray machine is operating. The device, connected to the primary voltage lines of an x-ray generator, provides a warning signal—flashing light, horn, or buzzer if it detects a voltage on the generator. The device may also be used as a safety monitor, or control element, on other types of variable voltage equipment. (auth)

4532 CRITERION OF APPROXIMATE SIMILITUDE OF AN ARC WITH A SELF-MAINTAINED LENGTH ARCING IN A PLASMATRON WITH A GAS EDDY STABILIZATION. Smolyakov, V. Ya. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 151-7(Jan.-Feb. 1967). (In Russian).

A criterion of approximate similitude of a dimensionless potential drop in a stationary vortex gas plasmatron was found for the case in which the length of the arcing is determined by shunting. The shunting creates an idealized arcing scheme most suitable for two types of plasmatrons with one- or two-sided vortex gas stabilization. The idealization of the actual complex processes taking place during arcing in the plasmatron permitted one to clarify some phenomena observed during experiments: e.g., abnormalities related to the arc intensity as a function of electrode diameter, arc length variations at different polarities, and quantitative variations of the voltage changes with the currents of direct and inverse polarities and with different gases. It was also observed that the generalized volt–ampere formulas may be used for approximate calculation of parameters of a plasmatron with a self-adjusting arc at such gas temperatures at which the thermal gas ionization outside of the arc is negligible and the shock ionization (for the air up to 5000°K) plays the most important part. (R.V.J.)

4533 EFFECTS OF CONVECTIVE HEAT-EXCHANGE ON PLASMATRON CHARACTERISTICS. Kutateladze, S. S.; Rebrov, A. K.; Yarygin, V. N. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 157-60(Jan.-Feb. 1967). (In Russian).

General data on plasmatron efficiency are summarized. Volt–ampere characteristics and equations for efficiency were obtained for the pressure range 760- to 32-mm Hg. The design of the plasmatron, including the preheater for low pressures is described. Heat exchange regularities in the plasmatron channel were investigated. The experimental data obtained for plasma flux contamination by electrode erosion products showed that the impurities did not exceed 0.002 wt % in the current ranging from 15 to 150 A. The effects of breakdown on energy processes in the plasmatron were also evaluated. (R.V.J.)

4534 INVESTIGATION OF PULSATIONS IN A PLASMATRON WITH A SELF-ADJUSTING ARC. An'shakov, A. S.; Dautov, G. Yu.; Mustafin, G. M.; Petrov, A. P. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 161-6(Jan.-Feb. 1967). (In Russian).

In the vortex-type plasmatron, shunting is one of the basic processes determining the heated gas properties. The following were studied previously: the mechanism of shunting and related pulsations; the relation between the current luminescence range at the plasmatron exit and the arc intensity; and the influence of gas and current consumption of the shunting frequency, as well as the existence of several anode spots in argon arcs. In the present work, voltage, current, and luminosity distribution functions were found and oscillograms are given of these magnitudes. Also, oscillograms are given of the current passing through the anode section. Various methods are used in order to demonstrate the feasibility of several simultaneous anode spots and the influence of the arc intrinsic magnetic field on the arc behavior. (R.V.J.)

4535 DISTRIBUTION OF ELECTRIC FIELD ALONG THE LONGITUDINALLY BLOWN ARC IN D-C PLASMATRON. Vasil'kovskaya, A. S.; Kolonina, L. I.; Lebedev, A. D.; Smolyakov, V. Ya. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 166-71(Jan.-Feb. 1967). (In Russian).

Experimental data are given on distribution of the electric field voltage along the arc, stabilized by the longitudinal-vortex air jet in a dc plasmatron. Measurements carried out with a potential probe showed the rise of voltage along the arc in the direction of the gas blowing in the arc. An attempt was made to explain such a rise by noting the rise of gas temperature due to the heat exchange within the arc. (R.V.J.)

4536 FEEBLE FIELD FEELER. Menke, J. L.; Schrack, R. A. (National Bureau of Standards, Washington, D. C.). Nucl. Instrum. Methods, 57: 158-9(Dec. 1967).

A simple magnetic field detector is described which allows measurement of magnetic fields to within 0.1 G. Together with its associated circuits it can be used to adjust an electromagnet system for minimum remanent field. (auth)

4537 SIMPLE TECHNIQUE FOR THE PREPARATION OF ULTRA-PURE BORON LAYERS. Van Audenhove, J.; Joyeux, J. (EURATOM, Geel, Belg.). Nucl. Instrum. Methods, 57: 157 (Dec. 1967).

A simple technique for the deposition under vacuum of ultrapure boron layers is described. After raising its electrical conductivity by preheating at 700°C in a small oven, the top of a boron rod is further heated by high frequency induction. A stable floating molten drop source with a controllable evaporation rate is obtained. (auth)

4538 IMAGE RESTORATION IN RADIOISOTOPE IMAGING SYSTEMS. Iinuma, T. A.; Nagai, T. (National Inst. of Radiological Sciences, Chiba, Japan). Phys. Med. Biol., 12: 501-9 (Oct. 1967).

In the radioisotope image visualization the final image must be interpreted by the human visual system. An inherent blurring of the image limits the amount of useful information which can be extracted from it. Attempts were made to restore the image by compensating for the degradation. By expressing the radioisotope image as a convolution integral of a true radioisotope distribution, with the spatial resolution of the imaging system, and by using an iterative approximation method for the evaluation of the integral, a restored image is obtained. An experimental result on a profile scan demonstrated the applicability of the method to radioisotope imaging systems. (auth)

4539 PHOTO-ELECTRONIC IMAGE DEVICES. Proceedings of the Third Symposium Held at Imperial College, London, September 20–24, 1965. McGee, J. D.; McMullan, D. (eds.). Advances in Electronics and Electron Physics. Volume 22B. New York, Academic Press, 1966. 390p. (CONF-650991-(Vol.22B)).

Separate abstracts were prepared for 6 of 32 papers presented. The remaining 26 papers were not in the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 4447, 4479, 4540, and 4541–4543.

4540 THERMAL-NEUTRON IMAGE INTENSIFIER. Niklas, Wilfrid F. (Rauland Corp., Chicago); Dolon, Paul J.; Berger, Harold. Advan. Electron. Electron Phys., 22B: 781-800(1966).

From Third Symposium on Photo-Electronic Image Devices, London, Sept. 20–24, 1965. See CONF-650991.

A thermal-neutron image intensification system is described. A neutron image tube is coupled with a television system for neutron inspection. Performance and use of the system for radiography are discussed. (W.H.K.)

4541 OBSERVATION OF CHERENKOV RING IMAGES WITH AN IMAGE INTENSIFIER SYSTEM OF HIGH GAIN. Iredale, P.; Hinder, G. W.; Parham, A. G.; Ryden, D. J. (Atomic Energy Research Establishment, Harwell, Eng.). Advan. Electron. Electron Phys., 22B: 801-12(1966).

From Third Symposium on Photo-Electronic Image Devices, London, Sept. 20–24, 1965. See CONF-650991.

Determination of particle velocities by analysis of Cherenkov ring images with an image intensifier system is described. Description and performance of the system used are discussed. (W.H.K.)

4542 IMAGE INTENSIFYING CHAINS FOR MEDICAL SCINTILLATION CAMERAS. Ball, Jack (Picker X-Ray Corp., Cleveland); Niklas, Wilfrid F.; Dolon, Paul J.; Ter-Pogossian, M. Advan. Electron. Electron Phys., 22B: 927-40(1966).

From Third Symposium on Photo-Electronic Image Devices, London, Sept. 20–24, 1965. See CONF-650991.

The design and performance of x-ray image intensifier systems for autoradiography are presented. The principal components are collimator, image intensifier tube, lens system, and recording system. (W.H.K.)

4543 SPARK CHAMBERS AND IMAGE INTENSIFIERS USED IN THE SCANNING OF RADIOACTIVE OBJECTS. Lansiart, A.; Roux, G. (CEN de Saclay, Gif-sur-Yvette, France). Advan. Electron. Electron Phys., 22B: 941-7(1966).

From Third Symposium on Photo-Electronic Image Devices, London, Sept. 20–24, 1965. See CONF-650991.

A self-triggering spark chamber and a light intensifying device used for scanning radioactive objects emitting x rays and gamma rays are described. The x-ray and gamma-ray energy range lies between a few keV and a few hundred keV. The resolutions obtained vary from 1 mm to 1 cm, depending on the devices used and the x- and gamma-ray energy. (W.H.K.)

4544 PROGRESSO ELETTRONICO. VOLUME SECONDO. Atti del XIII Congresso per l'Elettronica, Roma, 15–20 Giugno 1966. (Advances in Electronics. Volume II. Reports of the 13th International Congress for Electronics, Rome, June 15–20, 1966). Rome, Rassegna Internazionale Elettronica, Nucleare e Teleradiocinematografica, 1966. 305p. (In English and Italian). (CONF-660662-(Vol.2)). DTIE.

An abstract was prepared for only one of the twenty-one papers presented. The other papers presented were not within the scope of NSA. (B.G.D.)

For an abstract of the individual paper see: 4545.

4545 MEASUREMENT OF THE LUNAR SURFACE COMPOSITION USING NUCLEAR ACTIVATION ANALYSIS. Cuypers, M. Y.; Hislop, J. S.; Kuykendall, W. E.; Wainerdi, R. E. (Texas A and M Univ., College Station). pp 15-28 of Progresso Elettronico. Volume Secondo. Rome, Rassegna Internazionale Elettronica, Nucleare e Teleradiocinematografica, 1966.

From 13th International Scientific Congress for Electronics, Rome, June 15–20, 1966. See CONF-660662-(Vol.2).

Using 14-MeV neutron activation analysis a method of determining oxygen, aluminium, silicon, magnesium and iron, five of the major elements likely to be present on the lunar surface are described. This is based on the following nuclear reactions: $^{27}Al(n,p)^{27}Mg$, $^{27}Al(n,\alpha)^{24}Na$, $^{28}Si(n,p)^{28}Al$, $^{56}Fe(n,p)^{56}Mn$, $^{24}Mg(n,p)^{24}Na$, $^{29}Si(n,p)^{29}Al$, and $^{16}O(n,p)^{16}N$. A prototype system capable of remote analysis is also described along with considerations of hardware and telemetry requirements. (auth)

4546 YADERNAYA RADIOELEKTRONIKA. (Nuclear Radioelectronics). Tsitovich, A. P. Eksperimental'nye Metody Yadernoi Fiziki. II. (Electron Methods in Nuclear Physics. II). Moscow, Izdatel'stvo Nauka, 1967. 536p.

Lectures on nuclear radioelectronics presented at the Moscow Engineering Physics Institute were combined into a textbook including topics on elementary particle detectors, theory of measuring errors, and electron methods in nuclear physics. Nuclear detector schematic, G–M counter, quenching, gas discharge counter and spark chamber power supplies, PEM in spectrometers, amplification of detector signals, coincidence and anticoincidence methods, and multichannel analyzers are discussed. 194 references are included. (R.V.J.)

4547 PHOTO-ELECTRONIC IMAGE DEVICES. Proceedings of the Third Symposium Held at Imperial College, London, September 20–24, 1965. McGee, J. D.; McMullan, D.; Kahan, E. (eds.). Advances in Electronics and Electron Physics. Volume 22A. New York, Academic Press, 1966. 688p. (CONF-650991-(Vol.22A)).

Sixty-one papers are presented from the proceedings of the Third Symposium on Photo-Electronic Image Devices held at Imperial College, London, September 20–24, 1965. The papers are categorized under topics such as electronography, image tubes, signal generating tubes, image evaluation, photocathodes, phosphor screens, electron optics, and secondary electron emission. (B.G.D.)

4548 PROGRESSO ELETTRONICO. VOLUME PRIMO. Atti del XIII Congresso per l'Elettronica, Roma, 15–20 Giugno 1966. (Advances in Electronics. Volume I. Reports of the 13th International Congress for Electronics, Rome, June 15–20, 1966). Rome, Rassegna Internazionale Elettronica, Nucleare e Teleradiocinematografica, 1966. 1052p. (In English and Italian). (CONF-660662-(Vol.1)). DTIE.

An abstract was prepared for only one of the fifty-six papers presented. The other papers were not within the scope of NSA. These papers were categorized under headings such as characteristics and operation of semiconductor devices, integrated circuits, applications in telecommunications, automatic control, and computers. (B.G.D.)

For an abstract of the individual paper see: 4563.

4549 FAST PULSE GENERATOR UTILIZING AN ELECTRON BEAM TO CAUSE AN ARC BREAKDOWN ACROSS THE GAP REGION OF A COAXIAL LINE CENTER CONDUCTOR. Kerns, Quentin A. (to U. S. Atomic Energy Commission). U. S. Patent 3,360,678. Dec. 26, 1967.

A very rapidly acting switch particularly adapted for producing a very short and accurately timed pulse is described. The switch has a coaxial line configuration with a spark gap provided either in the center conductor or from the outer to center conductor. A small electron gun directs electrons across the gap, causing an arc breakdown. The low resistance of the arc effectively closes the switch. (AEC)

4550 PHASE MODULATED SOLID-STATE DEVICE. Pigg, Jay C. (to U. S. Atomic Energy Commission). U. S. Patent 3,358,245. Dec. 12, 1967.

A semiconductor device is provided which is especially useful in high-power, high-frequency applications. The device consists of a semiconductor crystal, a single carrier injecting source for introducing carriers into the crystal, a d.c. voltage applied across the crystal to cause the carriers to drift through the body of the crystal. Numerous electrical leads may be attached at intervals along the surface of the crystal body. A signal applied between the two leads closest to the carrier injection end of the crystal is amplified by the bunching effect which takes place in the crystal as the carriers drift through the body, and the amplified signal is detected between subsequent leads along the crystal. (AEC)

4551 DISTRIBUTED FEEDBACK STRIP TRANSMISSION LINE OSCILLATOR. Clark, Melvin D. (to U. S. Atomic Energy Commission). U. S. Patent 3,360,743. Dec. 26, 1967.

A compact strip line oscillator with stacked or planar triode tube is described. Feedback is achieved by mutual distributed capacitance and inductance of grid and plate lines. (AEC)

4552 VOLTAGE STRETCH CIRCUIT. Sedlmeyer, J. W. (to U. S. Atomic Energy Commission). U. S. Patent 3,356,961. Dec. 5, 1967.

A circuit is described for stretching in time and amplitude a signal pulse of short time duration, said circuit including a difference amplifier and utilizing both regenerative and degenerative feedback. (AEC)

4553 ATOMIC BEAM RESONANT DEVICE WITH A CAVITY RESONATOR HAVING TWO ARMS AND A LEG PORTION CONTAINING LOSSY MATERIAL. Holloway, Joseph H.; Rorden, Robert J. (to Hewlett-Packard Co.). U. S. Patent 3,354,307. Jan. 28, 1964.

An atomic resonant apparatus is described. The apparatus has means for producing a beam of atomic particles, a first state detector, means for exciting atomic resonance of the particles, a second state detector, and means for detecting resonance of the particles. This includes a cavity resonator for applying microwave electromagnetic energy to the particles to produce resonance. The cavity resonator has a particle-field interaction portion made up of a pair of arms and a leg joined to the arms at a waveguide junction. The Q of the arms is higher than 500 which is twice the Q of the leg portion. The total Q of the cavity is made less than the Q of the interaction portion to render the detected atomic resonance signal less responsive to detuning effects of the resonator. (U. S. Pat. Gazette)

4554 IMPROVEMENTS IN OR RELATING TO COLD CATHODE GLOW DISCHARGE DEVICES. Dugdale, Ronald Arthur (to United Kingdom Atomic Energy Authority). British Patent 1,093,133. Nov. 29, 1967. Filed July 16, 1965.

A cold cathode glow discharge device which may be used for heat treatment, welding, melting, or zone refinement of refractory materials is described. (M.O.W.)

4555 LIQUID METAL MONITOR Wilkinson, Keith (to United Kingdom Atomic Energy Authority). British Patent 1,093,224. Nov. 29, 1967. Filed Dec. 10, 1963.

The design of a liquid metal impurity monitor is presented. A plugging meter is employed which restricts the flow of the liquid metal depending on impurities present and regulated by the temperature and flowrate of the liquid metal. (W.H.K.)

4556 LEAK-TIGHT MOVABLE PIPE COUPLING. Vidor, Cyrille (to Commissariat a l'Energie Atomique). British Patent 1,093,159. Nov. 29, 1967. Priority date June 18, 1965, France.

The design of a pipe coupling that is movable and leak-tight is presented. It is designed to be resistant to corrosion and high pressures. The coupling is constructed with two flange plates designed so that one or both of the pipes may be rotated at the joint. (W.H.K.)

4557 IMPROVEMENTS IN OR RELATING TO ELECTRIC SWITCHES. Alston, Liviu Leonard; Rogers, Patrick Joseph (to United Kingdom Atomic Energy Authority). British Patent 1,094,191. Dec. 6, 1967. Filed Oct. 17, 1963.

The design of a mechanical switch that will carry 100 kA and will close in approximately 100 μs is presented. The switch consists of an insulator sandwiched between two expendable electrodes which are in contact with two main electrodes. The main electrodes have apertures through which a plunger is forced which pierces the sandwich, thus making electrical contact. (W.H.K.)

4558 IMPROVEMENTS IN OR RELATING TO ELECTRIC SWITCHES. Alston, Liviu Leonard; Rogers, Patrick Joseph (to United Kingdom Atomic Energy Authority). British Patent 1,094,192. Dec. 6, 1967. Filed Nov. 27, 1963.

A mechanical switch designed to close in 40 μs with 40 kV across it is described. A metallic layer is sandwiched between insulating layers which is sandwiched between expendable electrodes which are in contact with the main electrodes. One of the insulating layers has an aperture so that when a voltage is applied the other insulator is ruptured, thus closing the circuit. A metallic plunger is then forced through the sandwich to provide a low-resistance path. (W.H.K.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 5443, 5448, and 5449.

4559 (TID-24144) STRAIN GAGE PRESSURE TRANSDUCER EXPERIMENT 23/R511. FINAL DATA REPORT. NERVA PROGRAM. (Aerojet-General Corp., Sacramento, Calif.). Feb. 1967. Contract SNP-1. 39p. (RN-S-0326). Dep. CFSTI.

Four Statham Model PA-812 and four Standard Controls Corporation Model 170-9 pressure transducers were irradiated in the Plum Brook Reactor Facility at Sandusky, Ohio. Both sets of transducers were subject to output signal degradation in excess of 25% of baseline values at a gamma heating rate of 0.5 W/gm. However, inadvertent pretest water damage of transmission cable assemblies contributed to the signal degradation. Posttest examinations revealed that physically the strain gage portion of the Statham transducers satisfactorily withstood the exposure. The integrated fast neutron flux was 9.0×10^{15} n/cm^2 ($E_n > 1.0$ MeV); the gamma dose was 3.0×10^8 RADS (C). (auth)

4560 (UCRL-70646) EXPOSURE OF STRAIN GAGES IN RADIATION FIELDS OF NUCLEAR DEVICES. Lord, David E. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 18, 1967. Contract W-7405-eng-48. 66p. (CONF-671034-1). Dep. CFSTI.

From Western Regional Strain Gage Committee Meeting, Seattle, Wash.

Structural effects in radiation fields are of engineering interest and measurement of these effects should be made with sensors and systems which are preferably radiation effect immune. Evidence is presented to support the immunity of strain gages as structural measurement sensors in a nuclear device radiation field. The method of testing by mechanical stimulus and various system malfunction modes are discussed. (auth)

4561 PHOTON DEPENDENCE OF THERMOCOUPLE CALIBRATION. Dau, Gary J. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 638-9(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4562 DESIGN OF TEST FIXTURE FOR REMOTELY TESTING STRAIN GAGES IN A CRYOGENIC AND RADIATION ENVIRONMENT. Hart, W. M. (Aerojet General Corp., Sacramento, Calif.). Trans. Amer. Nucl. Soc., 10: 676(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4563 RADIATION DAMAGE ON SOME TYPES OF SEMICONDUCTORS. Galotto, C. P.; Gnavi, F. (Fiat Divisione Aviazione, Turin). pp 99-115 of Progresso Elettronico. Volume Primo. Rome, Rassegna Internazionale Elettronica, Nucleare e Teleradiocinematografica, 1966. (In Italian).

From 13th International Scientific Congress for Electronics, Rome, June 15-20, 1966. See CONF-660662-(Vol.1).

A few experimental results are outlined concerning the radiation damage produced by 45-MeV protons and 5- to 25-MeV electrons on certain n-p Si-type junctions. The magnitude of the damage is expressed in terms of the number of reticular centers displaced from their equilibrium position by the primary particle and by the consequent cascade process. This magnitude is related to the minority carriers lifetime, hybrid parameters, Y parameters, dispersion currents and saturation tensions. The magnitude of the damage is compared to that obtainable from adequate exposure to the radiation field from Van Allen belts. Finally, through irradiation with fission fast neutrons, it is shown that the damage produced by p and α particles can be predicted by means of adequate exposure of semiconductors to a flow of fast neutrons. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 4601, 4661, 4689–4691, 4699, 4702, 4711, 4713, and 6247.

4564 (N-67-18203) SOME BIOMEDICAL APPLICATIONS OF A NON-LINEAR CURVE FIT METHOD. Tyson, James W.; Meade, James H. Jr.; Dalrymple, Glenn V.; Marvin, Horace N. (Arkansas Univ., Little Rock. Medical Center). [1965]. 22p. (NASA-CR-81799). CFSTI.

A nonlinear curve fit method is applied to the estimation of parameters of three complex equations to illustrate its value to the biomedical investigator. The objective method does not require transformations or graphs, and can be successfully used for complex nonlinear equations. The first equation is used in hematology and pertains to the disappearance of the radioisotope ^{51}Cr from the blood. The second equation from radiobiology involves irradiation of cells and their subsequent loss of ability to perform sustained and repeated mitosis. The third equation comes from biochemistry and is also termed the Michaelis–Menton equation. It gives the velocity of reaction (moles reacted/unit time) as a function of substrate concentration (moles/unit volume). The three equations are examples of equations that must be fitted by some numerical method, equations that are commonly fitted by graphical means, and equations that require transformations for linearization. It is shown that these equations can be fitted by the same basic method and use of a small digital computer system for the calculations. (STAR)

4565 (TID-23990) RADIATION AND INFECTION. An Annotated Bibliography. Stoner, Richard D.; Hess, Max W.; Bond, Victor P. (comps.) (Brookhaven National Lab., Upton, N. Y.). May 1965. 272p. Dep. CFSTI.

A total of 819 abstracts are presented representing the world's published literature concerning the effects of ionizing radiation on infection and immune mechanisms. The abstracts are grouped according to the type of pathogen involved, and the type of suscept response or reaction. (E.R.B.)

4566 (TID-23990(Suppl.1)) RADIATION AND INFECTION. An Annotated Bibliography. Supplement 1. Stoner, Richard D. (comp.) (Brookhaven National Lab., Upton, N. Y.). May 1967. 124p. Dep. CFSTI.

Abstracts of 261 publications on the effects of ionizing radiation on infection and immune mechanisms are presented. The major part of the literature included is of Russian origin and may predate the intended inclusive dates of the supplement. The abstracts are grouped according to the type of pathogen involved and the type of suscept response or reaction. Cross references are given where a paper includes information covering more than one category. (E.R.B.)

4567 PHOSPHATASE MODELS AND THEIR BEHAVIOR TOWARDS SUBSTRATES OF THE INTERMEDIATE CARBOHYDRATE METABOLISM. Trapmann, H.; Devani, M. (Univ., Munich). Arch. Pharm., 298: 497-505(1967). (In German).

Both glucose-1-phosphate and glucose-6-phosphate are cleaved with Th(IV) and more slowly with Zr(IV) as catalyst; increasing the amount of the catalyst increased the rate of hydrolysis in both acid and alkaline media. Similar data for fructose-6-phosphate and fructose-1,6-diphosphate are given; Th(IV) proved to be a better catalyst for hydrolysis than Zr(IV) in both acid and alkaline media. For Th(IV) fructose-1,6-diphosphate was cleaved faster than fructose-6-phosphate, and the latter was cleaved at the same rate in acid solution as glucose-6-phosphate, but faster in alkaline. Glycerol-α-phosphate was cleaved faster than 3-phosphoglyceric acid by both Th(IV) and Zr(IV). Adenosine-3'-phosphate was hydrolyzed faster than adenosine-5'-phosphate in both acid and alkaline solution, Th(IV) being more effective than Zr(IV). Results were similar for adenosine triphosphate, the effect of Th(IV) being notably stronger than that of Zr(IV); in alkaline solution the concentration of Th(IV) did not affect the rate of cleavage. The expected dependence on concentration of Th was observed in acid, however. (BBB)

4568 INACTIVATION OF ESCHERICHIA COLI RIBOSOMES BY ULTRAVIOLET IRRADIATION. I. ACTIVITY OF POLY U-DIRECTED POLYPHENYLALANINE SYNTHESIS. Kagawa, Haruo; Fukutome, Hideo; Kawade, Yoshimi (Kyoto Univ.). J. Mol. Biol., 26: 249-65(June 14, 1967).

Inactivation of ribosomes, isolated from E. coli strains B and H, by uv irradiation (wavelength 253.7 mμ) was studied as regards the polyuridylic acid-directed polyphenylalanine-synthesizing activity. Ultraviolet inactivation of ribosomes of both strains obeyed single-hit kinetics, but the rate of inactivation was apparently different for the ribosomes of the two strains. Inactivation rates of the subunits were much smaller when uv irradiated in the 70S complex than in the dissociated state. A fraction of uv-irradiated subunits lost the ability to associate with the partner subunit. In the case of B strain ribosomes, another fraction of uv-irradiated subunits retained the ability to associate but failed to interact properly with the partner; furthermore, an active subunit appeared to select and associate preferentially with an active partner among a population containing such damaged subunits. In the 30S subunit, the target size of functional sites related to subunit interaction was much larger than that of functional sites unrelated to it. These results suggested that the interaction between the subunits was an intricate one and played a crucial role in the ribosomal function. The number of critical RNA bases, estimated from the inactivation cross-section, was much smaller than the total number of pyrimidine bases in the ribosomal RNA. (BBB)

4569 STUDIES ON CELLS PRODUCING HEMOLYTIC ANTIBODIES AGAINST SHEEP RED BLOOD CELLS IN SHORT-TERM EXPERIMENTS IN VITRO. Strander, H. (Karolinska Institutet, Stockholm). Immunology, 10: 45-55(Jan. 1966).

Radiobiologic experiments were conducted in the course of development of a system for the maintenance of isolated cells from mouse spleen during short periods in vitro. Active γM antibody synthesis continued throughout the experimental period. The number of antibody-producing cells remains unchanged when the synthesis of DNA was inhibited. X irradiation was shown to stop proliferation of antibody-forming cells and was used to assess the possible contribution of cell division to the number of plaque-forming cells (PFC). A dose of 1000 R, which should stop all cell division, had no apparent effect on the number of plaques formed. However, 10,000 R, which might disturb other processes besides cell division, reduced the number of PFC to 0 within 7 hr. This experiment indicated that cell divisions do not influence the number of PFC. The effects of puromycin, p-fluorophenylalanine, actinomycin D, and hydrocortisone were also tested and their dose-dependent effects established. γM antibody synthesis was shown to follow the same pattern as mammalian protein synthesis in general. (BBB)

4570 INTERACTION OF LASER RADIATION WITH BIOLOGIC SYSTEMS. III. STUDIES ON BIOLOGIC SYSTEMS IN VITRO. Klein, E.; Fine, S.; Ambrus, J.; Cohen, E.; Neter, E.; Ambrus, C.; Bardos, T.; Lyman, R. (Roswell Park Memorial Inst., Buffalo). Fed. Proc., 24: Transl. Suppl. 14, 104-10(Jan.-Feb. 1965).

A ruby laser operating at a wavelength of 6943 Å and energy levels ranging from 3 to 100 J per pulse with a pulse duration of ~1 msec was employed for most of these studies, but exploratory studies were also carried out with a pulsed-laser of neodymium-doped glass, operating at 10,600 Å and energy levels of over 800 J per pulse. Lipase activity in the presence of an energy transfer agent (methylene blue) was reduced by laser irradiation, while proteolytic activity, present as an impurity in these preparations, remained unchanged. Activity of fibrinolysin was reduced to different degrees by the irradiation in the presence of methylene blue. Irradiation of blood group substances increased the levels at which these preparations inhibited hemagglutination, as compared with nonirradiated control specimens. The reactivity of irradiated γ-globulin preparations with rheumatoid factor was decreased, as compared with the controls. However, the irradiated preparations gave peak titer reactions with antibodies at lower concentrations than controls. Irradiation of several species of microorganisms resulted in reduction of growth on subcultures and temporary changes in pigment formation. (BBB)

4571 LOSS OF ^{65}Zn FROM THE CALIFORNIA SEA-MUSSEL MYTILUS CALIFORNIANUS. Young, D. R.; Folsom, T. R. (Scripps Inst. of Oceanography, La Jolla, Calif.). Biol. Bull., 133: 438-47(Oct. 1967).

To determine the loss rate of ^{65}Zn in the California sea-mussel, colonies of Mytilus californianus averaging 11 cm in length were translocated from the vicinity of the Columbia River mouth to southern California waters, where much lower levels of ^{65}Zn occur. The colonies were suspended in nets at Scripps Institution of Oceanography Pier and were sampled periodically for one year. During this time, the concentration of ^{65}Zn in the soft tissues (after deducting radioactive decay) decreased by more than 97%. This

decrease appears to be described satisfactorily by a single exponential function, with a biological half-time for growing organisms of 76 ± 3.5 days. If radioactive decay is not excluded, the observed loss rate of ^{65}Zn is described by an effective half-life of 58 ± 2.7 days. (auth)

4572 MIGRATION OF CELLS TO THE THYMUS. Field, E. O.; Stanley, Elizabeth M. (Royal Marsden Hospital, Sutton, Eng.). Acta Haematol., 35: 221-31(Apr. 1966).

Irradiation experiments were conducted to follow the influx of lymphocytes into the thymus. The specific activity of thymic DNA was determined in mice given a single intraperitoneal dose of tritiated thymidine following whole-body irradiation, thymic irradiation, and thymic chilling. In normal mice the specific activity of the DNA remained unchanged for 24 hr following injection. After 500-R whole-body irradiation the DNA-synthesizing capacity of the thymus fell more steeply than after irradiation of the thymus alone. The specific activity of the DNA that was labeled while the thymus was chilled by means of a cold finger was reduced to 23.6% of the normal but rose progressively on warming. These results were explained on the basis of an influx into the thymus of cells originating elsewhere in the body. (BBB)

4573 TERMINATION OF ACQUIRED TOLERANCE BY ADMINISTRATION OF SMALL LYMPHOCYTES. Denman, A. Michael; Vischer, Thomas L.; Stastny, Peter (Univ. of Texas, Dallas). J. Immunol., 98: 442-5(Mar. 1967).

The ability of small lymphocytes obtained from the spleen and lymph nodes of normal unimmunized donors to confer antibody production upon irradiated isologous recipients that were rendered tolerant to the specific antigen prior to irradiation was investigated. These experiments were carried out to determine whether injected small lymphocytes alone were capable of replacing the deficiency of the tolerant rat or whether other cell types of the host were also involved in the tolerant state, and therefore similarly in need of replacement. X irradiation was carried out at ~96 R/min for a dose of 600 R. Immunologic tolerance was established in newborn Fischer rats by injection of sheep erythrocytes intraperitoneally within 24 hr of birth and twice weekly for 8 to 10 weeks thereafter. Administration of small lymphocytes obtained from the lymph nodes and spleens of normal isologous donors resulted in a restoration of the capacity for antibody production in the x-irradiated, neonatally tolerant rats. Lack of response in tolerant animals could be terminated with as few as 5×10^6 small lymphocytes. Simultaneous injection of tolerant cells did not influence this effect. Restoration of antibody production in x-irradiated rats could also be achieved with small lymphocytes from the blood, but small lymphocytes of the thymus were ineffective. Thus, the specific deficiency that existed in neonatal tolerance was corrected when normal small lymphocytes were given to neonatally tolerant rats. All other components of lymphoid tissue that may be required for the immune response evidently retained their function in the neonatally tolerant animal. (BBB)

4574 INACTIVATION OF DRY RIBONUCLEASE BY IONIZING RADIATION. II. A SUGGESTED MECHANISM. Ray, Dilip K.; Hutchinson, Franklin (Yale Univ., New Haven). Biochim. Biophys. Acta, 147: 357-68(Oct. 23, 1967). (NYO-2653-32).

Various kinds of damage were looked for in bovine pancreatic RNAase that was irradiated with γ rays in the dry state. For ribonuclease which had lost 80% of the initial enzymic activity on irradiation, less than 15% of the molecules had a broken polypeptide backbone as determined by column chromatography of the sample after oxidation by performic acid. Irradiation changed the ultraviolet absorption spectrum in such a way as to suggest that the environment of the tyrosyl groups was changed. This was confirmed by difference spectra and by spectrophotometric titration of the tyrosyl hydroxyl groups. Conformational changes in the molecule were also deduced from the action of trypsin on the irradiated enzyme. Treatment of irradiated ribonuclease with urea did not restore enzymic activity, showing that inactivation did not occur as a result of rearrangement of Van Der Waals bonds. From the results of this paper, as well as earlier results, it is suggested that a major cause of inactivation by ionizing radiation is a change in the overall conformation of the molecule induced by chemical modifications of the side chains. (auth)

4575 PARTITION COEFFICIENT OF ^{133}Xe BETWEEN VARIOUS TISSUES AND BLOOD IN VIVO. Andersen, Anne Marie; Ladefoged, J. (Glostrup Hospital, Copenhagen). Scand. J. Clin. Lab. Invest., 19: 72-8(1967).

In vivo studies were made on equilibrium distribution of ^{133}Xe in various organs of the rat and rabbit. The partition coefficients tissue : blood for most of the tissues were about 0.7, ranging from 0.58 (skeletal muscle) to 0.79 (thymus), with a value of 8.0 to 9.8 for fat tissue as the only exception. A positive, but statistically insignificant correlation between the partition coefficients and the fatty acid content in the tissues (excluding fat tissue) was found. Simultaneous measurements of the desaturation rates of ^{133}Xe and of ^{85}Kr from the kidneys in rabbits and man were carried out. In rabbits the 2 clearance constants were converted to blood flow data by multiplication with the partition coefficients. The mean ratio between the two sets of blood flow values was 1.03, which was not statistically different from 1. In man the mean ratio between the clearance constants for the 2 gases was 0.77, which agreed with the ratio between the partition coefficients for the 2 gases from animal experiments. (BBB)

4576 EFFECT OF IRRADIATION ON THE ANTISTREPTOKINASE ACTION OF EACA AND OF AHG. Szirmai, E. (Technische Hochschule, Stuttgart); Berkarda, B.; Derman, U. Nucl. Hematol. (Publ. Nucl. Energy), 6: 93-4(May-June 1967).

Studies of the in vitro effect of x irradiation on the fibrinolytic activity of streptokinase-streptodornase (Varidase) showed that 1200 R x irradiation did not significantly influence the activity of streptokinase-streptodornase (SK + SD). Streptokinase showed anticoagulant activity which was detected by thrombin-clotting time tests and coagulagrams, as well as fibrinolytic activity. The anticoagulant effect is probably caused by anticoagulants produced by the lysing of fibrinogen, which is activated by streptokinase, especially antithrombin. The influence of x irradiation on the in vitro action of a fibrinolysin-antagonist, ϵ-aminocaproic acid (EACA), on streptokinase-streptodornase, and of an activator of the blood clotting of antihemophilic globulin (AHG, factor VIII) was studied by determining the activity of EACA and AHG before and 24 hr after irradiation. Irradiation of EACA at a dose of 1200 R did not significantly diminish its inhibitory effect on SK and SD activity, which was checked on euglobulin clots and plasma plates. Irradiation at a dose of 1200 R did not diminish the repletion activity of AHG in recalcified plasma and partial thromboplastic clotting times. The observed shortening of the clotting time in both systems suggested an activation effect. (BBB)

4577 ENZYMATIC STUDIES IN THE COURSE OF THE SECONDARY SYNDROME. Schwarzmann, V.; Lapeyraque, F.; Berthaux, N. (Hopital Saint-Antoine, Paris). pp 365-8 of Colloq. Intern. Centre Nat. Recherche Scientif., Paris, Sept. 7-9, 1964. Paris, Editions du Centre National de la Recherche Scientifique, 1965. (In French).

Systematic clinical and experimental studies were performed on serum enzyme levels in irradiated subjects submitted to bone marrow grafting. In four patients, who received allogenic grafts after whole-body irradiation, enzyme assays were done before and after irradiation, before and after bone marrow infusion, and during development of the resulting secondary syndrome. Similar studies were conducted on mice receiving isologous and homologous grafts, except that liver rather than serum enzyme levels were determined. The changes in serum enzyme activity in the patients resembled closely those recorded in chronic hepatitis, a condition which seems to occur as one of the features of the secondary syndrome. Parallel studies carried on livers of irradiated and grafted mice failed to show any significant change related to secondary syndrome, with the exception of liver glutaminase I. Some changes in other liver enzymes seemed to have no significance in relation to the secondary syndrome since they occurred both in isologous and homologous groups. It is suggested that these liver enzyme changes (decrease of glutamic dehydrogenase and malic dehydrogenase activities) reflect irradiation effects on the liver. (BBB)

4578 SKIN-PHOTOSENSITIZING FUROCOUMARINS: PHOTOCHEMICAL INTERACTION BETWEEN DNA AND -$O^{14}CH_3$ BERGAPTEN (5-METHOXY-PSORALEN). Musajo, L.; Rodighiero, G.; Breccia, A.; Dall'Acqua, F.; Malesani, G. (Univ., Padua). Photochem. Photobiol., 5: 739-45(Sept. 1966).

After uv irradiation (3655 Å) of an aqueous solution of DNA and a skin-active furocoumarin, pronounced modifications in the fluorescence spectra of the solutions were observed, whereas in the presence of skin-inactive derivatives the spectra remained unchanged. By use of a labeled furocoumarin, i.e. -$C^{14}H_3$ bergapten or 5-methoxypsoralen, this reaction was confirmed and more extensively studied. During uv irradiation a stable combination of the furocoumarin with native DNA takes place with a quantum yield of 5.2×10^{-3}. It is probable that the reactive sites of DNA are the pyrimidine bases. Yeast RNA and the same DNA after heat denaturation or in the presence of high NaCl concentration photoreact at a much reduced rate. This photoreaction may explain some various biological photosensitizing effects produced by furocoumarins. (BBB)

4579 COMPARISON OF LOCALIZATION OF ACETYLCHOLINESTERASES IN SPINAL MARROW OF X-IRRADIATED AND NONIRRADIATED CHICKEN EMBRYOS. Denefle, Jean-

Pierre; May, Raoul-Michel (Univ., Paris). Arch. Sci. Physiol., 21: 81-90(1967). (In French).

Samples of spinal bone marrow from the lumbar-sacral region of 10 embryos of 7-day-old chickens were studied at various levels of the spine 4 hr after total irradiation in ovo, with a dose of 1500 R with 70 KV x rays. A control group of nonirradiated embryos was used. Bone marrow from both groups was fixed in formaldehyde after preincubation in the presence of acetylthiocholine iodide. Hydrolysis occurred at pH 6.2 and lasted 18 hr. Activity of AChE (acetycholinesterase) was greater in irradiated than in nonirradiated marrow. The increase was dependent upon variations in the topographical distribution of the enzyme. Although present in the Lissauer Zone and the spinal cord ganglia of irradiated and nonirradiated marrow, AChE was found in greatest abundance in the anterior motor horn cells of irradiated marrow. It is concluded that irradiation affects both sensory and motor structures in the developing central nervous system. (BBB)

4580 REPLY TO A NOTE BY R. B. SETLOW AND JANE K. SETLOW CONCERNING THE PROPER USE OF SHORT-WAVELENGTH REVERSAL OF ULTRAVIOLET LIGHT INACTIVATION OF NUCLEIC ACIDS. Kleczkowski, A. (Rothamsted Experimental Station, Harpenden, Eng.). Photochem. Photobiol., 4: 941-2(Sept. 1965).

After Setlow and Setlow (Proc. Nat. Acad. Sci., U. S., 48: 1250 (1962)) found that the inactivation of transforming DNA from Hemophilus influenzae by long-wave uv irradiation can be partially reversed by short-wave uv irradiation, attempts were made to determine if other nucleic acids behaved similarly. Tests were made with RNA from tobacco mosaic virus (TMV-RNA) and with DNA from a Rhizobium bacteriophage. The experimental results showed no reversal of inactivation. If, at similar proportions of inactivation by long-wave uv, there is very much less dimerization in TMV-RNA or in the phage DNA than in the transforming DNA, then it seems unlikely that dimerization plays any significant part in the inactivation of TMV-RNA and of the phage. This conclusion was supported by the fact that only about 0.19 J of radiation energy must be absorbed per mg of TMV-RNA, and 0.083 J per mg of phage DNA, to halve their infectivity. These amounts of energy are not likely to produce dimerization to any significant extent. It seems, therefore, that when these materials are irradiated with uv, they lose all their infectivity before any sizable amount of dimerization can occur. (BBB)

4581 THE UPTAKE OF RADIOACTIVE ZINC, CADMIUM, AND COPPER BY THE FRESHWATER SNAIL TAPHIUS GLABRATUS. Yager, Charles M. (North Georgia Coll., Dahlonega); Harry, Harold W. Malacologia, 1: 339-53(1964).

Laboratory reared Taphius glabratus (Australorbis or Planorbina) were exposed to concentrations of ^{65}Zn, ^{115m}Cd, or ^{64}Cu which allowed normal behavior, and to concentrations which resulted in the snail showing the distress reaction (incapacity to retract into the shell). Analysis of the radionuclide uptake of various body parts is reported. The parts were digested in concentrated nitric acid, following which counts of radioactivity were made. An average difference of 42.5% between the cpm/mg of the intact, live snail and summation of counts of the body parts after digestion was attributed to the difference in the geometry of counting. The difference was about equally divided between loss and gain after dissection, and showed no correlation with the weight lost in dissection, which averaged 18.1%. The uptake patterns were essentially the same for all 3 radionuclides. In normal snails, more radionuclide ions were taken up by snails exposed to larger volumes of dosing solution than was taken up by snails exposed to only 10 ml of solutions of the same concentration for equal periods of time. The uptake by the shell, in cpm/mg, decreased in experiments in which snails were exposed to 10 ml of dosing solution per snail, as time increased. In a given experiment, the uptake was of the same order of magnitude for all of the protoplasmic body except the liver, which showed 4 to 7 times the amounts present in other tissues. The liver in distressed snails had only twice the amount of radionuclide found in other tissues. Snails which showed normal activity often had much larger amounts of metal present in the protoplasmic tissues than did distressed snails. It was concluded that distress is dependent on the concentration of radioisotope rather than the amount absorbed, and that the ions are effective in producing distress by disrupting membrane permeability rather than by interfering with some internal metabolic mechanism. (BBB)

4582 TAGGING SANDFLIES WITH ^{32}P (DIPTERA, PSYCHODIDAE). Espinola, Helio N.; Da Silva, Joao E. (Univ., Minas Gerais, Brazil). Rev. Brasil. Biol., 25: 295-304(Oct. 1965).

A technique was developed for tagging sandflies with ^{32}P that could be used for studies of the ethology, biology, and ecology of these Psychodidae. Adults of Lutzomyia longipalpis (Phlebotomus longipalpis) were tagged with ^{32}P in the form of a $Na_2H^{32}PO_4$ solution added to the culture media. Two methods were tested for this purpose. The first consisted in tagging the adult sandflies through the 4th instar larvae (prepupal stage) by culture media containing 160, 80, 40, 20, 10, 5, and 1 μCi/g of ^{32}P. The second consisted in obtaining tagged adult sandflies by rearing them in the radioactive media from the egg stage. Since the insects in this group were expected to remain in the radioactive media for a longer time, the ^{32}P doses were reduced to 48, 24, 12, 6, 3, 1.5, and 0.3 μCi/g. Differences were found between the male and female counts that could be correlated with the inequality of weight and volume between the sexes. The ^{32}P radiation apparently did not cause any injury, either in morphology or in sandfly viability. The results of tagging adults starting from the eggs suggested that this method was preferable to the first, in view of the homogeneity of the counting results and because it avoided transfer of larvae from one medium to another. The differences found between the counts of the first and the last sandflies to emerge were probably due to ^{32}P decay. (BBB)

4583 THYROID FUNCTION AND IODINE METABOLISM IN SENESCENCE. Scazziga, B. R. (Clinique Medicale Univ., Lausanne, Switzerland). Schweiz. Med. Wochensch., 96: 1558-62(Nov. 19, 1966). (In French).

The relation of metabolism of radioiodine to aging is reviewed (38 references), particularly with reference to the author's studies of ^{131}I uptake and turnover in the thyroid gland of subjects aged 65 to 90 yr. Data on thyroxine, protein-bound iodine (PBI), and thyrotropin (TSH) plasma levels in aged subjects are also examined. It was concluded that radioiodine metabolism and thyroid function in older humans differ in 3 ways from that in younger subjects: thyroid-^{131}I uptake, conversion rate, and PBI values are slightly increased; binding of thyroxine by thyroxine-binding globulin is increased, while that by the prealbumins is decreased; and plasma TSH values are increased. In the light of these findings, some aspects of radioiodine metabolism in senescence are discussed. (BBB)

4584 EFFECTIVE HALF-LIFE OF ^{32}P IN THE SANDFLY LUTZOMYIA LONGIPALPIS (LUTZ AND NEIVA, 1912) (DIPTERA PSYCHODIDAE). Espinola, H. N.; Capunay, R.; da Silva, J. E. (Faculdade de Medicina, Minas Gerais, Brazil). Rev. Brasil. Biol., 26: 175-9(Aug. 1966).

Adult L. longipalpis were tagged by rearing the sandflies from the egg stage in a medium containing 100 μCi/g ^{32}P. Two counts of radioactivity were performed to determine the ^{32}P elimination rate, one just before adult emergence and another on the day of the adult's death. The biological half-life of ^{32}P in the males ranged from the second to the fourth after adult emergence and in the females, from the fifth to seventh day. By using the effective half-life formula, it was found that the half-life of ^{32}P in this species was 1.7 to 3.1 days for males and 3.7 to 4.7 days for females. From these data and previous results on the tagging of sandflies with ^{32}P, it was concluded that the ideal dose of ^{32}P for tagging of L. longipalpis was 20 μCi when the tagging was started at the egg stage and 10 μCi when tagging was started at the 4th larvae instar. These conclusions apply only when radioactivity counts are performed with a counter of the same type used in this experiment, or with one of equivalent sensitivity. (BBB)

4585 UPTAKE OF HEAVY METAL IONS BY TAPHIUS GLABRATUS, A SNAIL HOST OF SCHISTOSOMA MANSONI. Yager, Charles M. (North Georgia Coll., Dahlonega); Harry, Harold W. Exp. Parasitol., 19: 174-82(Oct. 1966).

Uptake of ^{65}Zn and ^{115m}Cd by T. glabratus was studied by radiochemical assay of various body parts and by autoradiography. In the case of both radioisotopes, the liver uptake was much greater than either the shell or the rest of the protoplasmic body. The limits of the maximum concentrations producing distress are indicated. Cadmium ion produced distress at a concentration of about one third that at which Zn was effective. The general pattern of uptake of the 2 radionuclides was about the same, despite differences in the effective concentration. A major exception was the relative amounts of the 2 ions taken up by shell and protoplasmic body exclusive of the liver. More ^{65}Zn was taken up by the shell than by the general protoplasmic body, whereas the opposite was true for ^{115m}Cd. Cadmium-115m in the general protoplasmic body increased in proportion to its external concentration to a greater extent than for ^{65}Zn. Within certain limits, the amounts previously taken up did not preclude the entry of more isotope. The chelating agent, ethylenediaminetetraacetic acid (EDTA) reduced the amount of these isotopes which entered the snail but to a different extent for each. About 62% of the initial ion taken up was retained 48 hr after the isotope was removed from the environment, and its distribution within the snail was about the same as initially. Autoradiographs showed a high concentration of ^{115m}Cd in liver, kidney, and oviduct, but there was little radioactivity in other structures. (BBB)

4586 ISOTOPES AND RADIATION TECHNOLOGY. Volume 4, Number 4. Baker, P. S.; Lafferty, Robert H. Jr.; Gerrard, Martha; Greene, R. E.; McKinney, F. E.; Carden, Joan E.; Miller, F. J.; Rupp, A. F. (eds.). Contract W-7405-eng-26. One of the Five Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Lab., Summer 1967. 32p. GPO $0.70 Domestic, $0.90 Foreign.

Separate abstracts were prepared on 16 papers in this review. Each deals with some aspect of radiation development, production, technology, and application. (E.R.B.)

For abstracts of individual papers see: 4003, 4004, 4163, 4273, 4312, 4313, 4587, 4609, 4716–4720, and 6246–6248.

4587 SUMMARY OF SYMPOSIUM ON RADIOISOTOPE TRACERS IN INDUSTRY AND GEOPHYSICS IN PRAGUE, CSSR, NOV. 21–25, 1966. Miller, F. J. Isotop. Radiat. Technol., 4: 369-79(Summer 1967).

Speakers at the symposium on Radioisotope Tracers in Industry and Geophysics in Prague reviewed many uses of radioisotope tracers in industrial studies and the various aspects of geophysics. Specific, individual cases in which radioisotope tracers were proven valuable were also presented by authors from 18 different countries. The topics for the sessions of the symposium were industrial applications of radioisotope tracers, friction and wear studies, geophysical applications, dispersion of effluents (miscellaneous applications), and plant kinetics. (auth)

Ecology

Refer also to abstract 4602.

4588 (COO–1559-2) TECHNICAL PROGRESS REPORT [ON ECTOPARASITES], SEPTEMBER 1, 1966–AUGUST 31, 1967. Allred, Dorald M. (Brigham Young Univ., Provo, Utah). Sept. 20, 1967. Contract AT(11-1)-1559. 2p. Dep. CFSTI.

Progress is reported on the identification of ectoparasites found on animals inhabiting the National Reactor Testing Station area. The collection of birds, mammals, and reptiles and the identification of a large number of fleas, lice, mites, and ticks are reported. (C.H.)

4589 EFFECTS OF TOTAL-BODY X-IRRADIATION AND AET ON THE ACTIVITY OF THYMIDINE–PHOSPHORYLATING KINASES DURING LIVER REGENERATION. Baugnet-Mahieu, L.; Goutier, R.; Semal, M. (CEN, Mol, Belg.). Radiat. Res., 31: 808-25(Aug. 1967).

Whole-body irradiation (1000 R) of rats delays the time at which maximal activity of the TdR phosphorylating kinases is reached in regenerating liver, if the irradiation is given before the appearance of kinase activity. The inhibition decreases when the lapse of time between irradiation and hepatectomy increases, indicating some repair in the protein-synthesizing system. When given during the period of increasing activity, 1000 R is no longer able to inhibit the kinase activity, but 1500 R exerts an inhibitory effect. The enzyme activity, therefore, is less radiosensitive than the synthesis of new enzyme molecules. When irradiation is given 20 hours after partial hepatectomy, at a time when kinase activity would no longer be inhibited, the rate of DNA synthesis measured at 24 hours is found to be decreased to about the same extent as DNA, polymerase activity. A radioprotective dose of AET injected in rats before partial hepatectomy also delays the onset of kinase activity. This is considered as a symptom of the metabolic shock induced by the sulfhydryl protector, which may be of some importance in the development of the protective power. A protective effect of AET on the radiation-induced inhibition of kinases is observed when the rats are irradiated before partial hepatectomy. In rats irradiated after hepatectomy, the protective effect of AET is masked by its greater toxicity to hepatectomized animals. (auth)

Genetics and Cytogenetics

Refer also to abstract 4703.

4590 (NYO–3314-10) GENETIC CONTROL OF AGING AND RADIATION-INDUCED LIFE-SHORTENING IN MICE. Progress Report, October 1, 1966–September 30, 1967. Yuhas, John M. (Jackson Lab., Bar Harbor, Maine). Sept. 30, 1967. Contract AT(30-1)-3314. 19p. Dep. CFSTI.

Experiments with mice were conducted to determine strain differences in the natural rate of aging, the extent of life-shortening induced by x radiation, accumulation of somatic mutations with age, and sensitivity to radioinduced mutations. The incidence of mutations in the liver and ova increased with age. In the cornea and spermatozoa there was no increase with age. Differences in genetic stability were demonstrated in hematopoietic cells of inbred strains. (H.L.W.)

4591 (ORO–2909-6) THE NORTHWARD MIGRATION OF CITRUS BY MEANS OF RADIATION-INDUCED MUTATION. Progress Report, October 1, 1966–June 30, 1967. Gregory, Walton C. (North Carolina State Univ., Raleigh). Aug. 1967. Contract AT(40-1)-2909. 14p. Dep. CFSTI.

Scions of citrus were isolated and x-irradiated following exposure to winter conditions at Raleigh, North Carolina. Sources of genetic variation between scions within irradiated buds were attributed to dominant mutations, mitotic crossing-over, frequency variation in the number of quantitative genetic changes induced, and selection among cell lineages of the original cell mass that received radiation. The ability of various hybrids of citrus to survive winter conditions was studied. (H.L.W.)

4592 (UCSF–10P2-36) SOME CHROMOSOME STUDIES WITH TRITIATED THYMIDINE. Wolff, Sheldon; Heddle, John A. (California Univ., San Francisco. Medical Center). Sept. 1967. Contract AT(11-1)-Gen-10. 18p. (CONF-670822–2). Dep. CFSTI.

From International Conference on Replication and Recombination of Genetic Material, Canberra, Australia.

It appears that aberrations as well as sister strand exchanges are independent of the dose of tritiated thymidine within the range of doses ordinarily used. This qualitative similarity gives added support to the notion that the sister strand exchanges could be induced by the endogenous radiation rather than represent the genetic phenomenon of spontaneous sister strand crossing over. The notion that there is a complete nonrandomness in the distribution of chromatids after labeling was not confirmed. On the contrary, results indicate that chromatids proceed to the poles randomly. (auth)

4593 A DETERMINATION OF MUTAGEN SPECIFICITY IN BACTERIA USING NONSENSE MUTANTS OF BACTERIOPHAGE T4. Osborn, Mary; Person, Stanley; Phillips, Stephen; Funk, Fred (Pennsylvania State Univ., University Park). J. Mol. Biol., 26: 437-47(June 28, 1967).

In the course of studies on Escherichia coli mutants induced by β radiation, uv light, and chemical agents, a method was developed for determination of mutagen specificity in bacteria. An E. coli strain was used that is mutant because of an amber triplet in a gene necessary for arginine biosynthesis. Numerous revertants occurring spontaneously and after treatment with 5-^{3}H-uracil radioactive decay, ethyl methane sulfonate 2-aminopurine, 5-bromodeoxyuridine, hydroxylamine, and uv light were tested for their ability to support the growth of 24 amber mutants and 1 ochre mutant of bacteriophage T4. Regardless of the mutagen used to produce the revertants, only six patterns, called classes, of phage growth were obtained. Revertants of classes 1, 2, and 3 contained amber suppressors, revertants of classes 4 and 5 contained ochre suppressors and those of class 6, since they suppressed none of the mutant phages used, were assumed to be structural gene revertants. From the patterns of phage growth obtained, compared to those for bacterial strains with characterized suppressors, the amino acid inserted by a revertant of class 1, 2, or 3 was inferred. Strikingly different distributions into the classes were observed for some of the mutagens. 2-Aminopurine, ethyl methane sulfonate, and 5-^{3}H-uracil radioactive decay were specific in their action. (BBB)

4594 KARYOLOGICAL INVESTIGATION OF PERSONS THAT WERE SUBJECTED TO IRRADIATION. Borodkin, P. A.; Belyakov, V. A.; Gol'dman, I. L. Genetika, No. 7, 119-28(July 1967). (In Russian).

Experimental study and chromosome analyses of leukocytes in cultures of peripheral blood taken from 2 persons (a man and a woman) exposed to systematical professional irradiation are described. The main parameters (aneuploidy, heteromorphism of homologous chromosomes, structural abnormalities and associations of acrocentric chromosomes) were studied. In the irradiated persons the frequencies of aneuploid cells (with the number of chromosomes 2n not equal 46) were 8.3 and 14.2% in the man and the woman respectively, while in the control the corresponding frequencies were 8.1 and 8.5% in the man and the woman respectively. The proportion of chromosomal-type aberrations was relatively small: 1.3 (the woman) and 1.2% (the man). (auth)

4595 RADIATION-INDUCED CHROMOSOME ABERRATIONS IN HUMAN LEUKOCYTES IN VITRO, RADIOSENSITIVITY OF CHROMOSOMES, AND THE DOSE-EFFECT RELATIONSHIP. Suskov, I. I. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, No. 7, 112-18(July 1967). (In Russian).

The action of soft x-rays at doses of 25, 50, 100, 200, and 400 R on the chromosomes of human leukocytes was investigated in primary cultures. The types of chromosome aberrations in cells and their possible combinations are described. The origin of aberrations involving two breaks without any concomitant fragments is discussed. Distribution of induced aberrations involving one and two chromosomal-type breaks follows Poisson's distribution. In the control cells the frequency of spontaneous chromosomal-type breaks was 0.0023 per cell or 0.000050 breaks per chromosome. In irradiated cells the frequency of induced chromosomal-type breaks was 0.0025 per cell per R or 0.000054 per chromosome per R. The coefficients of incidence of chromosomal aberrations are $(0.09 \pm 0.01) \times 10^{-2}$ fragments per cell per R and $(0.41 \pm 0.08) \times 10^{-5}$ dicentrics and rings per cell per R. The dosage-effect curve for one-break aberrations corresponds to the one-hit kinetics, that for aberrations involving two breaks corresponds approximately to the two-hits kinetics. (auth)

4596 THE EFFECT OF ADRENALECTOMY ON THE RADIOSENSITIVITY OF CHROMOSOMES IN THE BONE-MARROW CELLS OF WISTAR RATS. **Logvinova, V. V.; Kerkis, Yu. Ya. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Genetika, No. 7, 50-6(July 1967). (In Russian).**

Twenty-four hours after whole-body x irradiation at doses of 50 R, 100 R, and 150 R, the frequency of chromosome aberrations in the cornea of adrenalectomized rats was significantly lower than in that of control rats. This result is contrary to those obtained in similar experiments with mice and golden hamsters. In bone-marrow cells, no difference in radiosensitivity was observed. It was suggested that there exists unequal realization of protective and and recovery processes in different mammals after adrenalectomy. (auth)

4597 EFFECT OF DIFFERENT TYPES OF IONIZING RADIATIONS ON THE INITIATION OF CHROMOSOME ABERRATIONS IN PEA. II. DOSE AND DOSE-RATE EFFECT ON THE FREQUENCY OF CHROMOSOMAL ABERRATIONS INDUCED BY ^{60}Co GAMMA-IRRADIATION OF PEA SEEDS. **Akopyan, E. M. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, No. 7, 34-8(July 1967). (In Russian).**

In order to obtain sufficiently precise dose-effect curves for the total proportion of damaged cells and for the numbers of chromosome fragments and bridges, pea seeds were irradiated by different doses of γ rays within the range from 1.5 to 40 kR at dose-rate values of 4200, 700 and 70 R per min. The material was fixed at the beginning of the first post-irradiation mitosis. The linear dose-effect curves for chromosomal aberrations and typical saturation curves for the proportion of damaged cells were obtained. Dose rate of 4200 R per min was 2.5 and 1.6 times as efficient as 70 and 700 R per min, respectively, while 700 R per min was 1.7 times as efficient as 70 R per min. (auth)

Health Physics and Safety

Refer also to abstracts 4396–4399, 4458, 4538, 4571, 4637, 4638, 4666, 4682, and 6206.

4598 (AD-648299) LINEAR ENERGY TRANSFER SPECTRA AND DOSE EQUIVALENTS OF GALACTIC RADIATION EXPOSURE IN SPACE. **Schaefer, Hermann J. (Naval Aerospace Medical Inst., Pensacola, Fla.). Dec. 9, 1966. 22p. (NAMI-987). CFSTI.**

In assessing the astronaut's exposure from galactic cosmic rays on space missions of long duration, conversion of absorbed doses to dose equivalents is required. Since a large part of the dose contribution from heavy primaries is produced at Linear Energy Transfer (LET) values beyond the range for which radiobiological data are available, it seems preferable to analyze the LET distributions themselves and to compare them to standard x rays rather than to assume arbitrary values for the Relative Biological Effectiveness (RBE). The local LET distributions in tissue are found to be extremely skewed, with a large maximum at the relativistic minimum LET. Lined up on the LET scale, they cover the very wide interval from 0.18 to 2790 keV/micron T as compared to an interval from 0.4 to 35 keV/micron T for standard x rays. Applying the RBE formula of the RBE Committee of the ICRP and a saturation value of 10 leads to a grand mean RBE of 1.82 for the total absorbed dose of 13 millirads/24 hours from primaries. (auth)

4599 (AD-648319) PUBLIC INFORMATION AND KNOWLEDGE REQUISITES OF A SHELTER SYSTEM. Final Report. **Bend, Emil; Cohen, Susan; McDaniel, Clyde (American Institutes for Research, Pittsburgh, Pa.). Sept. 1966. Contract OCD-PS-64-57). 156p. (AIR-D-93D-9/66-FR). CFSTI.**

Public information requirements for effective use of the shelter system are comprised of three separate but related parts. The first is an analysis of the types of items that make up the minimum required public information content for effective shelter system use. Public information in regard to threat warning, shelter-taking, and in-shelter survival is discussed. The audience for shelter information, the timing of shelter information campaigns, and the media for public information are also discussed. The second part of the report consists of a description of a shelter information study, in which 278 volunteers for AIR shelter research projects are interrogated on the nature and extent of their information and misinformation about shelter-related subject matter. Questions were asked about knowledge of warning signals, emergency communications, shelters and shelter supplies, fallout and its effects. The last section of the report contains the results of a content analysis to the public between 1959 and the present time. The purpose of the analysis was to discover the emphases and trends in the shelter-related guidance that the Government has made available to the public. (TAB)

4600 (BNL-11877) RADIAL DISTRIBUTION OF DOSE ALONG HEAVY ION TRACKS, LET_r. **Baum, J. W.; Stone, S. L.; Kuehner, A. V. (Brookhaven National Lab., Upton, N. Y.). [1967]. 25p. (CONF-671109-1). Dep. CFSTI.**

From Symposium on Microdosimetry, Ispra, Italy.

The radial distribution of dose for 100 to 300 keV protons incident on hydrogen was calculated with the aid of a digital computer. Cross sections, differential in angle and energy, provided input data on ejected electrons. In the absence of published data, a curve for dE/dx of 0 to 1 keV electrons in hydrogen was generated from available cross section data. Dose contributed by each electron was then considered and summed to arrive at ergs/cc as a function of radial distance from the track and integral dose out to various radial distances. A 3-foot long, 1-foot diameter cylindrical ionization chamber with segmented collection electrodes was employed in the experimental portion of the investigation. The segmented electrode permits collection from portions of the chamber which are in equilibrium with the secondary electron distribution. By lowering the pressure in the chamber, the radial dose distribution is expanded for measurement of LET_r. Measurements of LET_r are reported being made for alphas incident on various gases. Results are compared with values predicted by the calculations for protons on hydrogen, Jaffé theory, and calculations based on recent work of Butts and Katz. (auth)

4601 (CEA-R-3234) CARACTERISTIQUES DE L'APPAREIL RESPIRATOIRE UTILISABLES EN RADIOPROTECTION. (Characteristics of Breathing Apparatus Used in Health Physics). **Perissin-Pirasset, Francois (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). June 1967. 66p. (In French). Dep.**

The present state of knowledge makes it possible to envisage the calculation of doses absorbed by various parts of the respiration apparatus following inhalation of radioactive dusts contained in aerosols. After recalling certain anatomical and histological considerations, various curves showing the deposition of dusts in the three parts of the breathing apparatus are presented including the nasopharynx, the trachea and windpipe, and the pulmonary parenchyma. The dusts can be classified in three groups of biological solubility according to the rates of elimination of the particles from the organs. A synthesis of these data is given in elimination diagrams. In order to calculate the doses it is necessary furthermore to know certain anatomical and physiological characteristics of a standard man. (auth)

4602 (COO-1514-3) DISTRIBUTION OF MALLARDS FROM THE COLUMBIA BASIN REGION AS INDICATED BY THE PRESENCE OF ^{65}Zn IN BIRDS SHOT BY HUNTERS IN THE PACIFIC AND CENTRAL FLYWAYS. Final Progress Report, June 1, 1965–May 31, 1967. **Glover, Fred A.; Whicker, F. Ward; Buller, Raymond J. (Colorado State Univ., Fort Collins, Research Foundation). June 1967. Contract AT(11-1)-1514. 36p. Dep. CFSTI.**

Research was conducted to determine if the presence of ^{65}Zn in mallards shot by hunters in the Pacific and Central Waterfowl flyways would indicate an affinity to the Columbia Basin area; and to conduct preliminary studies on ^{65}Zn uptake and retention by penned mallards. Some of the mallards utilizing the Columbia Basin become tagged with ^{65}Zn from the effluent of the reactors located on the Columbia River at Hanford, Washington. A gross area survey of 17 states was made in the 1965–66 season but in 1966–67 attention was focused on the four states closest to the radioactive source: Washington, Oregon, California, and Idaho. A total of 6,594 mallard wings were scanned for ^{65}Zn, of which 134 were found to be ^{65}Zn positive, 118 in 1965–66 and 16 in 1966–67. All of the wings containing significant amounts of ^{65}Zn were from mallards shot in

Washington and Oregon. Difference between the two seasons is considered to be an expression of ^{65}Zn available in habitats utilized by mallards. This condition might have been caused by the reactor shutdown. Based on data obtained from experiments with 37 penned, adult mallards it was found that: ^{65}Zn was retained on the surface of externally contaminated mallards variable lengths of time depending upon the length of time the bird had access to uncontaminated water; and the biological half life of ^{65}Zn averaged 47.4 days with free access to clean water, 67.2 days with limited access to clean water, and 72.3 days when the feed was spiked. From the spiking of feed it was found that 86.5% of the oral dose was eliminated and 13.5% retained by the duck. A dose of 3.2 μc of ^{65}Zn was adequate for detection during the study period. (auth)

4603 (JAERI-5016) ACTIVITIES IN THE DIVISION OF HEALTH PHYSICS AND SAFETY, APRIL 1, 1966–MARCH 31, 1967. (Japan Atomic Energy Research Inst., Tokyo). May 1967. 167p. (In Japanese). Dep.

During this fiscal year, the construction of facilities was carried out mainly in the Oarai Area, where a radioisotopes facility was almost completed and the JMTR is expected to be in operation at the end of the next year. In the Tokai Area the development of new facilities was almost finished with the construction of the FCA and the steady operation of the installed reactors and other facilities. Radiation work was performed under higher radiation levels accompanied with the repair and modification of the reactors. The increased possibilities of contamination and internal exposure should also be taken into account more carefully in the production of radioiodine, in the operation of fuel exchange of the heavy water moderated reactors (JRR 2 and JRR-3), and handling of plutonium in the special laboratory and plant. The amount of liquid and solid waste was doubled in this year, as well as the number of various samples submitted for measurements. Annual statistics of personnel exposure for external radiation showed that the average exposure and the maximum integrated exposure during the year were both about one half of those in the preceding year, and exposure in the finger tips was negligible. Contamination of floors and air also, and consequently the abnormal internal exposures, decreased. In addition, the frequency of injury of personnel and the total rest time of the injured personnel were one half and one fifth respectively, compared to those of the last year. These results, indicated that, besides the improvement of safety organization and enhanced understanding of safety by personnel, positive countermeasures prepared by the Division were adequate and worked successfully. (auth)

4604 (LA-3696) RADIATION CHARACTERISTICS OF ^{238}Pu. Matlack, George M.; Metz, Charles F. (Los Alamos Scientific Lab., N. Mex.). Sept. 1967. Contract W-7405-eng-36. 12p. Dep. CFSTI.

The primary hazard in the use of ^{238}Pu as a biomedical power source results from the neutron flux caused by spontaneous fission and (α,n) reactions with light elements. Spontaneous fission will cause an activity of approximately 2200 neutrons per gram-second for material containing 81% ^{238}Pu. Neutrons from (α,n) reactions can increase this value to 8,000 to 10,000 unless every effort is made to produce ^{238}Pu which is extremely free of light element impurities. Most of the gamma radiation is of low energy and easily shielded. A significant fraction of the gamma radiation will, however, be caused by the growth of ^{241}Am, and by the 4n heavy element decay chain resulting from the decay of small amounts of ^{236}Pu. Gamma radiation from spontaneous fission and fission-product decay will be negligible. (auth)

4605 (NP-17083) RADIOACTIVITY SURVEY DATA IN JAPAN, NUMBER 15. (National Inst. of Radiological Sciences, Chiba (Japan)). May 1967. 29p. Dep.

Data are presented from fallout monitoring programs in Japan during May, 1967. Data are included on the content of ^{137}Cs and ^{90}Sr in samples of rain water and dry fallout collected from various locations throughout Japan; the content of ^{144}Ce, ^{137}Cs, and ^{90}Sr in air-borne dust; the content of ^{90}Sr in human deciduous teeth collected from various locations in Japan; the content of ^{137}Cs in human organs sampled in 1965; the content of ^{226}Ra in bone samples: the content of ^{137}Cs and ^{90}Sr in milk during 1966; the content of ^{137}Cs and ^{90}Sr in the total diet during 1966; the content of ^{137}Cs and ^{90}Sr in various kinds of fishes measured from 1963 to 1966; the content of ^{137}Cs and ^{90}Sr in water supplies during 1966; and the content of ^{144}Ce and ^{137}Cs in surface sea water sampled from 1963 through 1966. (C.H.)

4606 (NP-17146) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 5, Number 9. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Sept. 1967. 21p. Dep.

Fallout data collected in Canada during August, 1967 are presented. Data are included on the total β activity in atmosphere and precipitation and on the content of ^{137}Cs, ^{89}Sr, and ^{90}Sr in milk. Samples were collected at representative locations throughout the country. Data are also included from the reactor environment monitoring program during the same period. (C.H.)

4607 (NYO-3364-36) THE CORRELATION BETWEEN THE PRECIPITATION AND THE CONCENTRATION OF ^{137}Cs IN COW'S MILK IN NORWAY. Stroemme, Aksel (Statens Radiologisk-Fysiske Laboratorium, Oslo (Norway)). [1967]. Contract AT(30-1)-3364. 8p. Dep. CFSTI.

Results of analyses of samples of cow's milk from 270 dairies in the spring of 1966 are presented. The precipitation in May, June, and July and the total precipitation for 1966 were correlated with the ^{137}Cs content of milk during the spring of 1967 for three zones. Tables and graphs are presented to show results. (H.L.W.)

4608 (UR-49-861) ANALYSIS OF DEPTH DOSE DATA. Keller, Bowen Eliot (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). Nov. 10, 1967. Contract W-7401-eng-49. 189p. Dep. CFSTI.

Thesis.

Depth dose data published in Supplements 5 and 10 of the British Journal of Radiology were extended to cover a wide variety of field areas. A computer program was developed for depth dose analysis using the IBM 360/44. Measured and theoretical values were compared with values of depth dose obtained by computer. In most cases computer-derived values compared favorably with those obtained by other means. (H.G.D.)

4609 REVIEW OF A REPORT ON PROMPT Γ GAMMA RAYS FROM RADIATIVE CAPTURE OF THERMAL NEUTRONS. Green, R. E. Isotop. Radiat. Technol., 4: 340-58(Summer 1967).

A report on prompt-gamma rays from radiative capture of thermal neutrons (IITRI-1193-53, Vols. 1 and 2), prepared by R. C. Greenwood and J. H. Reed, is reviewed. The report contains an atlas of thermal neutron capture gamma ray spectra measured under standard conditions using NaI(Tl) scintillation detectors, and a comprehensive compilation of the neutron capture gamma ray data that was available prior to May 1965. Prompt-gamma ray spectra and data from more than 70 naturally occurring stable elements, a few naturally occurring radioactive elements, some separated isotopes, and some fissionable materials are given. Also included are the experimental arrangements and procedures for obtaining the neutron flux, neutron cross section, gamma ray intensities, and spectrum measurements. The objective of this work was to provide sufficient data concerning neutron capture gamma ray spectra to allow evaluation of practical uses of an analytical method based on the detection of neutron capture gamma rays in measurement, analysis, and control technology and to facilitate the use of such a method in these applications. Sample pages from the atlas are included. (auth)

4610 RADIATION ACCIDENTS IN PEACE TIME. PROBLEMS OF DOSIMETRY AND MEDICAL SERVICES. PART I. REVIEW OF ACCIDENTS IN NUCLEAR INDUSTRY IN THE YEARS 1945–1964. Kajek, Vlastimil (Slovak National Uprising Military Hospital, Ruzomberok, Czechoslovakia). Voj. Zdravot. Listy, 36: 80-3(Apr. 1967). (In Czech).

Various accidents which happened in nuclear industry in the USSR in 1953 are described. Two men who received doses of 300 and 450 R recovered fully in 18 months. A Czechoslovak accident which happened in 1960 is discussed. A boy carried a 150 mC cobalt radiation source for 45 minutes, but was not hurt. In another Czechoslovak accident in 1963, 13 men were moving a container with 2000 C of ^{60}Co when the container was damaged. The highest exposure rate was 17.5 R and no serious damage was caused. (JPRS)

4611 RADIATION HAZARDS AND PROTECTION IN THE MEDICAL USE OF DIAGNOSTIC X RAYS. Elicano, Tranquilino Jr. (Philippine Cancer Society, Manila). J. Philipp. Med. Ass., 42: 179-82(Apr. 1966).

The radiation hazards of diagnostic x-ray examinations are defined and suggestions as to how the medical profession may eliminate or greatly minimize these radiation hazards are presented. Since the Philippine Atomic Energy Commission has had limited authority to inspect only installations utilizing radioisotopes and there was no government agency actively checking diagnostic x-ray centers for radiation protection facilities, a unit created to supervise radiation protection measures and minimize radiation hazards in the use of diagnostic x-ray equipment is described. This unit will be coordinated with the Philippine Atomic Energy Commission. Some recommendations made to users of diagnostic x-ray equipment are as follows: if possible, avoid x-ray exposure, especially during the first trimester of pregnancy; diminish fluoroscopic exposure whenever possible; use

optimum filtration on the primary beam; use the smallest possible aperture to limit the radiation of the area of interest; use high-speed films and high-speed intensifying screens; and protect the gonads of the patient whenever possible. (BBB)

4612 MANAGEMENT OF THE ACUTE RADIATION SYNDROME. Darte, J. M. M.; Little, W. M. J. Can. Dent. Ass., 33: 20-4 (Jan. 1967).

A description is given of the management of persons who have been exposed to ionizing radiation under conditions where large numbers of casualties would occur. While designed mainly for application during the period after a nuclear attack, the principles also hold in a situation following a nuclear accident involving moderate numbers of casualties. Classification of casualties according to the dose received was considered to be not feasible since it was not possible to estimate the dose accurately in a manner that could be related to the biological state of the patient. Even if it were, inconsistent results would arise from irregular distribution of the dose. Therefore, classification of radiation injury was put on a clinical basis for determining priorities of evacuation and treatment in a mass casualty situation. Victims of nuclear attack will probably also suffer traumatic and thermal injuries. Four categories of surgical injury were therefore combined with three categories of radiation injury to yield 12 classes of patients whose disposition is described. The treatment of the acute radiation syndrome is discussed and the concurrent injuries from trauma, burns, and their possible implications are considered. It may be necessary to sustain the patient for as long as eight weeks, by which time recovery should be established. The initial stages of recovery may be heralded by a rise in reticulocytes or platelets before there is any apparent change in white blood counts. (BBB)

4613 EFFECT AND DOSAGE OF IONIZING RADIATION (CONCLUSION). Pohlit, W. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Roentgenpraxis, 18: 7-16 (Jan. 1965). (In German).

Procedures and methods for measurement of radiation dose are discussed. The section devoted to the dosimetry of x irradiation includes absorption of photon radiation in homogeneous and inhomogeneous materials, various methods for estimation of dose, measurement of standard ion dose, definition of the standard ion dose, evaluation of depth dose curves, and a summary of the dosimetry of conventional x rays. The second section is devoted to the dosimetry of high-energy bremsstrahlung with energies greater than 3 MeV, and a brief section is concerned with the dosimetry of γ irradiation, with energies of 1 to 2 MeV. Measurements of the energy dose were performed with either a standard ion dose chamber or with an ionization chamber, using a correction factor to obtain equivalent dose values. Applications of these principles to measurements in organ phantoms, bone, and air are described and illustrated. (BBB)

4614 CLINICAL MEASUREMENTS OF BODY RADIOACTIVITY. Burrows, Belton A.; Tyson, Ian; Dukstein, Walter G.; Genna, Sebastian (Boston Univ.). Trans. Amer. Clin. Climatol. Ass., 77: 25-33 (1965).

Design and construction of whole-body counters and their clinical use with low doses of radiosodium, radiopotassium, and radioiron, with consequent lowering of patient radiation exposure, are described. Measurements of whole-body radioactivity with apparatus of different sensitivities and with different physiological models involving either uniform and constant, or nonuniform and changing counting geometry are reported. Certain advantages of these techniques over conventional balance methods for body composition measurements and studies of absorption or retention of labeled compounds are enumerated. A very small amount of injected ^{22}Na, insufficient to affect exchangeable Na values, could be detected at intervals of 1 and 2 yr later. This ^{22}Na was apparently fixed in bone, and demonstrated a prolonged biological half-life. The amounts present were roughly comparable to the amounts of naturally occurring ^{40}K and the ^{137}Cs from fallout. For measurement of naturally occurring ^{40}K for estimation of body K, an isotope of K with a short half-life and almost identical γ-ray energy, ^{42}K, was used to correct for body geometry and self-absorption. Following a small tracer dose of known amount, the counts obtained from ^{42}K could be compared with counts obtained from ^{40}K to estimate the amount of ^{40}K. For some tracer studies the assumption made in the case of ^{42}K of uniform or constant distribution may not have been valid. A given subject could be measured shortly after an intravenous tracer to establish the 100% value but the relation of subsequent counts to the initial one might be influenced by changes in body distribution of the isotope. This would be the case with radioiron absorption and distribution. For such studies, a 2-crystal counting set-up was developed which minimized the effects of changes in distribution and corrections were made for these changes by an analysis of the γ-ray spectrum. Phantom studies indicated that greater absorption of the photopeak radioactivity resulted in increased counts in the Compton region. A ratio of counts in the photopeak to counts in the Compton region could therefore be used to correct for differences in absorption. Such correction reduced the counting changes following an intravenous dose of ^{59}Fe from a maximum of -8% to -3% in 8 normal subjects. (BBB)

4615 FEDERATION DENTAIRE INTERNATIONALE RULES FOR DENTAL RADIATION HYGIENE. Int. Dent. J., 16: 541-6 (Dec. 1966).

Recommendations are made for limiting radiation exposure to patients and personnel in dental radiographic procedures. Dental radiography should be limited to cases in which the information likely to be obtained will contribute materially to proper diagnosis or prevention of disease. The previous history of the patient's radiation exposure, especially to the head and neck, must be considered in making such an evaluation. The diameter of the useful beam as it strikes the skin should not be more than 75 mm where periapical or bitewing film is employed. Total filtration in machines operating up to 70 kV should be the equivalent of at least 1.5 mm of Al and up to 2.5 mm for 70 to 100 kV. The machine should have a timer cord of at least 2 m in length. Gonadal exposure may be halved by using an open-ended shielded cone, easily substituted for the pointed plastic cones in standard use. The x-ray machine should have a visible or audible signal that operates when x rays are being generated. The leaded apron should be used with children, women in the reproductive ages, and other patients if the anticipated gonadal exposure is much larger than the gonadal exposure resulting from daily exposure to natural background radiation. Use of high-speed film is an important factor in reducing radiation to the patient. Some additional factors in radiation hygiene are also considered, including use of structural shielding to protect persons in and outside the room where the radiation exposure is occurring and personnel monitoring with film badges. (BBB)

4616 RADIOACTIVE CONTAMINATION OF FOOD IN 1964. Haken, J. W. (Keuringsdienst van Waren, Amsterdam). Voeding, 26: 525-33 (Sept. 15, 1965). (In Dutch).

Extensive data are given for the ^{90}Sr and ^{137}Cs content of rainwater and food in the Netherlands. Results of semi-continuous survey of milk, bread, and meat, and 80 analyses of vegetables and various food items are included. The values are expressed in pCi/l and mCi/Km^2 for rainwater, pCi/Kg and pCi/g Ca for ^{90}Sr in food, pCi/Kg for ^{137}Cs in food. For 1964, the mean ^{90}Sr to Ca ratio in milk was 26, decreasing towards the end of the year; the mean ^{137}Cs content was 127 pCi/Kg, also decreasing toward the end of 1964. In bread, the level of contamination was higher than in 1963: ^{90}Sr 33 pCi/Kg and ^{137}Cs 48 pCi/Kg. In vegetables, the mean ^{90}Sr content was 23 pCi/Kg, while the ^{137}Cs content amounted to 28 pCi/Kg; both figures were considerably lower than the 1963 results. Meat contained on the average 450 pCi/Kg ^{137}Cs. The daily per capita intake for the year 1964 was calculated at 43 pCi ^{90}Sr and 170 pCi ^{137}Cs. For the 3rd to 6th months, the mean ^{90}Sr content of rainwater was 24 pCi/l, the ^{137}Cs content also 24 pCi/l. For the 7th to 12th months of 1964 these figures were 7 and 15 pCi/l respectively. (BBB)

4617 LIGHT-ABSORPTION CHARACTERISTICS OF TUMOR TISSUE AT RUBY AND NEODYMIUM LASER ENERGY WAVELENGTHS. Hume, Roxane; Ketcham, Alfred S.; Minton, John P. (National Cancer Inst., Bethesda, Md.). J. Surg. Res., 6: 531-5 (Dec. 1966).

Ruby (6943 Å) and neodymium (10,600 Å) laser radiation absorption by 62 human neoplasms was studied; the absorption characteristics of Cloudman S91 melanomas obtained from CDF_1 hybrid mice were used as reference points. The absorption capacity of each primary tumor was independent of the site or organ of origin or of the histological type. It was concluded that generalizations relating to light-absorption capacities could not be made concerning types of tumors when exposed to laser energy, but only concerning individual tumors and tumor implants. A table is presented that lists the numbers of tumors studied, the microscopic interpretation of the types of tumors, sites or origin of the tumors, and percentage ranges and average light absorptions of the tumors at the ruby and neodymium wavelengths. It was apparent that even lower wavelengths than those included in this experiment might be more effective in destroying tumors. (BBB)

4618 COMPARATIVE TOXICITY AND EFFICACITY OF FOUR FERROCYANIDES IN DECONTAMINATION OF RADIOACTIVE ^{134}Cs. Brenot, A.; Rinaldi, R. (Centre d'Etudes Nucleaires, Grenoble, France). Pathol. Biol. Sem. Hop., 15: 55-9 (Jan. 1967). (In French).

The toxicity and decontaminating effectiveness of four salts of

hydroferrocyanic acid, namely salts of Fe(III), Co(II), Bi(III), and Ca(II) were studied in Wistar rats given ^{134}CsCl by mouth. The results indicated that following the administration of the Co salt 94.6% of the radioisotope given was eliminated within three days. The rates of elimination of the radioisotope under the influence of the Fe and Ca salts were comparable but their toxicity was four times higher than that of the Co salt and consequently the latter was preferable for removal of radiocesium. The acute toxicities of the compounds, evaluated in adult C3H/JAX mice, were as follows ($LD_{50/30}$); ferrocyanides of Co(II) 4.09 mg/g, Fe(III) 1.13, Bi(III) 0.891, and Ca(II) 0.903. Autoradiography was used to confirm the removal of radiocesium from the muscle tissue of rats treated with the various ferrocyanide salts. (BBB)

4619 RADIATION HAZARDS. Williams, Katherine (Atomic Energy Research Establishment, Harwell, Eng.). Postgrad. Med. J., 42: 652-5(Oct. 1966).

Biological effects of radiation are reviewed in relation to hazards of overexposure to radiation, particularly occupationally. Late results of body contamination by various radioisotopes are considered, as are monitoring procedures to prevent such exposure. For internal exposure, preventive measures are exceedingly important because of the difficulty of ridding the body of absorbed radioisotopes and thus the exposure period may extend over the remaining lifespan of the individual. Particularly dangerous are those α- and β-emitting radioisotopes which are known to be deposited in bone. After intake, excretion of Ra is incomplete and build-up occurs in the skeleton with deposition in those osteons that are being formed at that time giving hot spots. This may lead to tumors of mesenchymal cells (sarcomata) and of epithelial cells (carcinomata) in immediate apposition around the bone. It is only in the case of Ra that there is any considerable amount of information, in all other cases of bone-seeking isotopes the prediction of permissible levels of body radioactivity was done by a comparison of the energies per disintegration emitted by the radioisotope and Ra. No bone tumors were found where the total body burden was below 0.4 μCi Ra. (BBB)

4620 PHYSICS APPLIED TO ANESTHESIA. VIII. IONIZING RADIATIONS. Hill, D. W. (Royal Coll. of Surgeons of England, London). Brit. J. Anaesth., 39: 335-42(Apr. 1967).

Radioprotection problems encountered by the anesthesiologist and their solution are discussed. From the viewpoint of the anesthetist and surgeon, it is important to consider the precautions that are taken in tube design to minimize stray radiation which could strike the operating team. Shielding is accomplished by fitting a lead screen around that part of the tube where the x rays are produced, leaving only a small exit port. In the latest x-ray models a series of metal diaphragms can be placed in front of the tube exit window to define the limits of the emergent beam as required. Unwanted leakage and scattered x radiation from the tube are of great concern to the surgeon and anesthetist. The leakage radiation from the tube shield must be limited to 100 mR/hr at 1 m, when the tube is run at its maximum rated output. In practice the leakage radiation from British x-ray tubes is less than $\frac{1}{10}$ of the permitted amount. The longer exposures required during fluoroscopy present the greatest risk to the surgeon and anesthetist due to the presence of stray x radiation scattered from the patient and surroundings. In general, the use of image intensifiers during fluoroscopy has not greatly reduced the x-ray tube current employed. It is desirable for the surgeon and anesthetist to wear lead-lined aprons and film badges. Lead-lined screens may also be placed around the patient to limit scattered radiation. (BBB)

4621 Pu IN NUCLEAR REACTORS. V. SAFETY PROBLEMS IN THE HANDLING AND PROCESSING OF Pu. Bucci, P. (CAMEN, Pisa, Italy). Ing. Nucl., 7: No. 3-4-5-6, 31-8(May-Dec. 1966). (In Italian).

The toxic nature of Pu and the maximum permissible concentration of its isotopes in air are discussed. The method adopted for handling and processing of Pu is principally glove boxes. The circumstances under which these may be used are discussed. Additional precautions to be taken in the handling of Pu are tabulated. (J.S.R.)

4622 THE PRELIMINARY OBTAINING OF ISODOSES FOR TELECOBALT THERAPY IN THE CROWN. da Rocha, A. F. G.; Legare, J.-M. (Hopital da Cruz Vermelha Brasileira, Rio de Janeiro, Univ. of Montreal). Acta Radiol., Ther., Phys., Biol., 6: 241-54(June 1967). (In French).

Precalculated dose distributions were obtained for crown and oblique ^{60}Co γ beam teletherapy. Optimum distribution was obtained by simply shifting the patient's cross-section over the isodose distribution. Comparison between various treatment plans showed that the simple crown technique gave better dose distribution than two oblique fields with the same angle of incidence. Because of its excellent tumor-dose distribution and low (20 to 40%) skin and subcutaneous dose, the double-crown technique was found to be superior to multiple-field and rotation therapy. (auth)

4623 RADIOLOGICAL STUDIES OF SO-CALLED RETROTRACHEAL GOITERS IN EARLY CHILDHOOD. Glatzl, J.; Riccabona, G.; Berger, H. (Univ., Innsbruck). Ann. Paediat., 207: 222-35(1966).

A comparison was made of radiation exposure in 56 young children examined for retrotracheal enlargement of the thyroid by x rays and ^{131}I. Lateral x-ray pictures were taken with the neck in retroflected position, and scintiscans obtained in the same position after administration of a tracer dose of ^{131}I were superimposed on the x-ray films. Thus retrotracheal masses could be identified as part of the thyroid gland. The ^{131}I dose (10 to 27 μCi) was given by mouth. Dosimetric calculations revealed that the maximum average radiation dose to the thyroid after a tracer dose of 12.5 μCi ^{131}I would be 18.5 rad. Estimations of the whole-body dose gave an average figure of 10 mrad for this series. In comparison, radiation doses delivered to the thyroid by routine x-ray techniques were estimated to vary from 90 to 720 mrad. The radiation exposure with the diagnostic use of ^{131}I was well within tolerable limits as determined by such dosimetric calculations. (BBB)

4624 THE PROSPECTS FOR IMPROVEMENT OF THE RADIATION CLIMATE IN DIAGNOSTIC AREAS. Wachsmann, F.; Leupold, W. (Univ., Erlangen-Nuernberg, Ger.). Roentgenpraxis, 19: 131-5(1966). (In German).

Results are reported of studies which indicate that there are now unused possibilities to reduce the irradiation dose received by physicians and patients. It was suggested that added shielding of rooms and spaces used for irradiation would be effective in reducing exposure to radiation; scattered radiation may be reduced considerably by this step. The effects of changes in room size on the effects of scattered radiation are also discussed. Use of a shielded room for x-ray photography is illustrated and discussed. The relation between gonadal dose from primary irradiation to tube voltage was studied. Evidence indicated that the male gonadal dose could be reduced by a factor of ~2.5 more when x-ray photographs were taken in a steel walled chamber instead of one with Pb/wood walls. Measurements showed that the half-value thickness of the scattered radiation in the chamber was only ~$\frac{1}{3}$ as great in the steel chamber. With 60-KV and 100-KV x rays the values observed with steel walls were 0.08 and 0.22 mm of Cu, respectively, while with Pb/wood walls the analogous values were 0.16 and 0.30 mm of Cu. (BBB)

4625 RADIOACTIVE CORPSES. Clarke, K. H. (Cancer Inst., Melbourne). Brit. Med. J., 2: 178(July 15, 1967).

Comments are added to a previous report on hazards associated with and improved regulations for handling deceased patients who had been treated with radioisotopes shortly before death. Rules enforced in the institute are briefly described. The procedure used for warning the mortuary attendant that a body was radioactive was as follows: For all large radioisotope therapy doses the patient was admitted to hospital for an appropriate time, dependent on the nature of the isotope and its biological half-life, and a note was sent to the pathologist to the effect that: If patient X presents for necropsy before a certain date he is to be regarded as a radioactive hazard and the physicist called. The note was posted in the mortuary and discarded after the given data. The responsibility for the issue of this note was designated to the senior staff of the radioisotope unit. (BBB)

4626 EXAMINATION OF DECONTAMINATION OF SURFACE. Miazek-Kula, M.; Smal, Z. (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: Suppl., 131-8(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10-12, 1964. See CONF-640210.

Results of investigations of the electrolytic decontamination of acid-proof steel contamination of PVC foil, glass, and acid-proof steel contaminated with ^{32}P, ^{35}S, ^{90}Sr(^{90}Y), and ^{131}I are presented. The influence of kind of electrolyte, current density, condition of contaminated surface, and electrolysis time on electrolytic decontamination are reported. The effects of the kind and concentration of detergents on the decontamination are reported for distilled H_2O, H_2SO_4, HNO_3, and caustic soda. (auth)

4627 MEASURING PLUTONIUM IN WOUNDS: ADVANTAGES OF USING THE AMERICIUM GAMMA RAY. Cloutier, R. J.; Watson, Evelyn E. (Oak Ridge Associated Universities, Tenn.). Health Physics, 13: 811-13(July 1967).

The plutonium in wounds may contain appreciable amounts of ^{241}Am. When the Am/Pu activity ratio is known, the amount of ^{239}Pu can be measured by means of the 59.6-keV gamma of ^{241}Am. Since the self-absorption factor of a particle in a wound cannot be measured and is more variable for lower energies, a more

accurate estimate of the plutonium content of the wound will be made if the 59.6-keV gamma measurements of ^{241}Am are used instead of the 17-keV x ray of ^{239}Pu. (auth) (UK)

4628 CODE OF PRACTICE AGAINST RADIATION HAZARDS. Fifth Edition. Imperial Coll. of Science and Tech., 1966. 51p.

Basic control procedures with which organizations must comply when carrying out work involving sources of ionizing radiation are outlined. Details of the methods to be used in implementing the basic control procedures are presented in relation to the following: legislation, protection of personnel, hazards from ionizing radiation, x-ray equipment, particle accelerators, reactors, classification of radioisotopes and grading of laboratories, specifications for radiochemical laboratories, handling of sealed and unsealed sources of radioactive materials, storage, transport, disposal of radioactive waste, monitoring, and accidents and emergency procedures. (27 references). (B.H.S.)

Medicine

Refer also to abstracts 4424, 4542, 4543, 4612, 4620, 4622, 4625, 4667, 4676–4679, and 4681–4685.

4629 (NYO-3723-1(Rev.)) FURTHER INVESTIGATION OF THE ROLE OF ^{75}Se METHIONINE UPTAKE IN THE DIAGNOSIS OF LYMPHOMA. Herrera, N. E.; Gonzalez, R. D.; Kranwinkel, R. (Danbury Hospital, Conn.). [1967]. Contract AT(30-1)-3723. 17p. (CONF-670940-3; CONF-670952-1). Dep. CFSTI.

From Symposium on the Clinical Applications of Nuclear Medicine, Boston, Mass.; American Society of Clinical Pathologists, Chicago, Ill.

Photoscanning of suspected body regions for lymphomas was performed following intravenous injection of ^{75}Se-labeled methionine. Photoscans were made at 30 min and at 24 and 48 hr. In one case the photoscan was positive as late as 2 weeks after injection of the labeled methionine. Photographs of scans showing the presence of Hodgkins disease, lymphoma, and lymphosarcoma in various regions of the body are presented. It is concluded that this technique is a reliable method for the diagnosis and study of lymphomas. (H.L.W.)

4630 (UCLA-34P119-16) RECENT DEVELOPMENTS IN NEW AGENTS, INSTRUMENTATION, AND TECHNIQUES FOR TUMOR LOCALIZATION. Tubis, Manuel; Crandall, Paul H.; Cassen, Benedict; Blahd, William H. (California Univ., Los Angeles. School of Medicine). Aug. 16, 1967. Contracts AT(11-1)-34; AT(04-1)-Gen-12. 7p. (CONF-670948-1). Dep. CFSTI.

From Symposium on Radioactive Isotopes in the Localization of Tumours, London, England.

The development of radiopharmaceuticals for scanning and visualization of organs for tumors and defects is reviewed. The use of ^{131}I-labeled benzoic acid and ^{131}I-labeled sulfobromophthalein for liver scanning; ^{99}Tc-labeled cystine, methionine, and a polypeptide for pancreatic scanning; and a chelate of ^{51}Cr and tetracycline for detection of brain tumor are discussed. Preliminary studies of chelates of ^{113}In and acetyl acetone are reported. Agents potentially adaptable to scanning were evaluated using the high-speed section scanner. (H.L.W.)

4631 (USNRDL-TR-67-87) INCREASED SURVIVAL OF IRRADIATED DOGS GIVEN TYPHOID VACCINE BEFORE OR AFTER IRRADIATION. Ainsworth, Earl J.; Mitchell, Fred A. (Naval Radiological Defense Lab., San Francisco, Calif.). July 28, 1967. 21p. CFSTI.

Previous studies showed that Typhoid-Paratyphoid vaccine (TAB) increased survival of irradiated dogs when given 24 hours before irradiation, but not when given one hour after irradiation. In extending the studies with dogs treated with TAB 24 hours before irradiation, we observed that lowering the TAB dose from 1.0 ml to 0.5 ml, with the intention of lowering toxicity to the animals, resulted in a smaller increase in survival. The LD_{50} of 457 R obtained for dogs given 1.0 ml of TAB 24 hours before irradiation was approximately 140 R higher than for normal dogs. The pattern of postirradiation leukocyte counts in TAB treated dogs was of particular interest. The most salient feature was a transient rise in the number of circulating granulocytes which occurred during the second week after irradiation. Both the extent of the rise and the number of circulating granulocytes after the rise was radiation dose dependent. Although the rise in granulocytes was quite impressive and could contribute to the animals' survival, the experiments with dogs treated 24 hours after irradiation showed that survival was increased in the absence of the rise. These survival results are discussed in terms of TAB-induced changes in the bone marrow. (auth)

4632 (AERE-Trans-1073) IN VITRO DETERMINATION OF THYROID FUNCTION WITH THE SERUM *T_3 TEST. Stumpf, W.; Graul, E. G. Translated by E. F. Towndrow (Atomic Energy Research Establishment, Harwell, Eng.), from Med. Klin. (Munich), 58: 192-6(1963). 10p. Dep. CFSTI. UK. 1s. 9d.

A description and preliminary results are given of a new and easily conducted in vitro test for thyroid function. The method, called the serum *T_3 test, consists of determining the protein-bound ^{131}I-l-3,5,3′-triiodothyronine which is obtained after a 1/4-hour incubation of serum with this hormone, followed by separation using gel filtration (Sephadex G-25). (auth)

4633 COMBINED TREATMENT OF PULMONARY METASTASES WITH IRRADIATION AND CYTOSTATIC DRUGS. Papavasiliou, C. G. (Univ. of Athens). Amer. Rev. Respirat. Dis., 95: 854-60(May 1967).

The synergistic effect of chemotherapy with methotrexate on radiotherapy of multiple metastatic tumors involving both lungs was investigated in nine patients. One lung was irradiated as the control; later the other lung of the same patient was irradiated concomitantly with administration of methotrexate. Before and after completion of the two therapeutic regimens, the size of the tumors was measured and the results were compared. The criterion for improvement was the extent of tumor regression two to three weeks after completion of therapy. In four patients better results were obtained with the combined use of radiation and methotrexate as compared with the controls that only underwent radiotherapy. In three patients regression was about equal or insignificant for the two groups of lesions. In these patients no improvement was obtained, and therefore there was no advantage gained by combined therapy. In two patients complete regression was obtained in both lungs. (BBB) (TSS)

4634 ISOTOPE-ENERGIZED RADIOGRAPHY. Stinchcomb, T. G. (Illinois Inst. of Tech., Chicago). Med. Biol. Illus., 27: 123-4(Apr. 1967).

Use of radioisotopes for medical and biological radiography is described, and results are given for techniques using a ^{147}Pm source. Advantages and disadvantages over conventional x-ray methods are outlined. Two disadvantages are the much lower intensity of radiation available from such sources, necessitating longer exposure times, and the greater area from which the radiation is emitted, with consequent loss of definition on the radiograph. On the other hand, radioactive sources are small, easily portable, and independent of external sources of power. The penetrating γ radiation from Ra made it especially suitable for the radiography of dense material, but the production of radioisotopes of many elements added greatly to the repertoire of such sources of radiation. Samarium-152, ^{155}Eu, ^{60}Co, and ^{137}Ca are widely used and have largely replaced Ra as radiographic sources. Iodine-125 and ^{169}Yt [^{169}Yb] are successfully used for medical radiography. The chief innovation brought about by the availability of a wide range of radioisotopes was the production of the new class of x-ray sources. These were obtained by using β-emitting isotopes to excite the characteristic x radiation from target elements with which they are mixed. Almost monochromatic x radiation over a wide range of frequencies may be produced by choosing the appropriate combination of emitter and target element, and by attention to the geometry of the arrangement so as to produce the required filtration. Many combinations of emitter and target have been investigated. In some cases the emitter may act as its own target. (BBB)

4635 LONG-TERM OBSERVATION ON THE HEMOPOIETIC FUNCTION OF THE ATOMIC BOMB SURVIVORS AND THE DISTURBANCES DUE TO THE IRRADIATION ON THE HEMOPOIETIC ORGANS. Wakisaka, Gioichi (Kyoto Univ.). Nagasaki Igakkai Zasshi, 38: Suppl., 166-76(Dec. 1963). (In Japanese).

The changes in hemopoietic function as a result of exposure to atomic bombing were studied over a 17-year-period. Among the 61 cases of atomic bomb survivors examined from 1945 to 1960, the white blood cell counts had decreased immediately after the bombing. As time passed, the decrease of leukocytes was gradually less marked. However, many cases still showed a decrease in leukocytes 15 yr after the bombing. Red blood cell counts and hemoglobin levels also showed decreases after the bombing. There were fluctuations in the values of the red cell counts and hemoglobin in these patients and many low values were still observed 15 yr later. Cell counts in bone marrow showed an increase in immature neutrophils, decrease of mature neutrophils, and increase in lymphocytes. The disturbances of hemopoietic function were considered mainly due to exposure to neutrons, and γ rays. Experiments were performed to examine the effects of neutrons on hemopoietic tissue. Several strains of two-month-old mice were irradiated with neutrons for 52 min. The accumulated doses were 1.1×10^{11}, 7.9×10^{10}, and 4.7×10^{10} cm^2. With the

lowest dose the leukocytes gradually decreased to below 1000 per mm^3 three days after irradiation and died. With the second dose some mice showed decreases in leukocytes at four days after irradiation and died at seven days while other mice survived up to four weeks or recovered. In the third group the decrease of leukocytes was less than 10% and the mice recovered after four weeks. (BBB)

4636 SKELETON AND COBALT THERAPY IN THE ADULT. Desproges-Gotteron, R.; Lacorre-Coussy, J.; Picot, H.; Toulza, H. Rhumatologie, 17: 207-14(May 1965). (In French).

A clinical study was made of radioinduced complications among 783 patients treated with ^{60}Co for various diseases, including 31 bone tumors. The advantages of ^{60}Co therapy over conventional radiotherapy are discussed. Treatment of bone tumors with γ radiation is reviewed. Side-effects due to radiotherapy can be avoided to some extent with supervoltage sources. Injuries that occurred, and are described, were; skin burns, subcutaneous sclerosis, and bone fractures. Late sclerosis of connective tissue is less evident with high-voltage than orthovoltage x-ray therapy but increases with doses of γ radiation higher than ~4500 rad. Spinal cord injury following irradiation of intestinal tumors was observed in two cases. In irradiation of the neck region a dose of more than 4000 R over a period of five to six weeks may be hazardous. Bone damage observed included; rib fractures in 13% of 243 cases of breast tumors, and neck fractures in 2% of cases. Bone injury did not appear on radiography initially. Maxillary injuries occurred in two out of 30 irradiation treatments of face and mouth tumors. It was concluded that irradiation was responsible for necrosis in some instances after treatment with orthovoltage x rays (130 to 200 KV) at total dose of 2000 to 7000 R. The risk of bone fracture increases if more than one series of irradiation is undertaken or after treatment at supervoltage levels (telecobalt therapy or betatron therapy). Despite these complications, the benefits of comfort and prolonged survival of the patients given ^{60}Co therapy justify its use. (BBB)

4637 BIBLIOGRAPHY OF SOVIET LITERATURE ON RADIOBIOLOGY FOR THE SECOND HALF OF 1965. Astakhov, I. A. Med. Radiol., 12: No. 11, 82-6(Nov. 1967). (In Russian).

References are presented to 88 Soviet publications during the last half of 1965 that discuss radiobiological studies. References are included on: techniques using radioisotope tracers for the diagnosis of various pathological conditions; radiotherapy of neoplasms; and radiation protection. (C.H.)

4638 FIFTY YEARS OF SOVIET RADIOBIOLOGY. Vorob'ev, E. I.; Funshtein, L. V. Med. Radiol., 12: No. 11, 8-25(Nov. 1967). (In Russian).

A brief review is given of achievements in radiobiological studies in the Soviet Union during the past 50 years. Early methods used for diagnosis, therapy, and radiation protection are described. Recent studies on the initial biological effects of radiations, the effects of radiation injuries on metabolism, the effects of radiation on biological materials at the cellular and subcellular level, the effects of radiation on the nervous system, radioinduced hemorrhage, genetic and somatic effects of radiation, and the effects of radiation on immune reactions to tissue transplants are discussed briefly. Improvements in radiotherapy and radiation protection are discussed. (20 references.) (R.V.J.)

4639 TREATMENT OF RADIATION SICKNESS WITH PYRIDOXINE HYDROCHLORIDE IN OUTPATIENTS OF A RADIOTHERAPY UNIT. Mattie, H. (Univ. of Leiden); Emery, E. W.; Hill, I. D.; Laurence, D. R. Brit. Med. J., 2: 206-8(July 22, 1967).

In an attempt to reassess the value of pyridoxine on radiation sickness, which manifests itself as a complex of subjective, often vague, complaints, mixed with symptoms due to the original disease or to anxiety, treatment was conducted in a double-blind procedure. Patients complaining of anorexia, nausea, and malaise received pyridoxine treatment routinely, 25 mg thrice daily. A placebo or a dummy tablet was not used as the general conviction of the therapist was that pyridoxine was an effective drug. Two different dose levels were used (1-mg and 50-mg tablets); one tablet thrice daily was administered with doubling of the dose if the patient did not respond. Thus the maximum daily dose with the low-dose tablets (6 mg) was somewhat more than the biological need, while with the high dose regimen, it was 300 mg. The duration of the entire trial was 24 weeks, divided into eight 3-week periods. During each period the central source of tablets contained either all high-dose tablets or all low-dose ones. There were four periods of high (H) and four of low (L) in the total of eight periods in the order HLLHLHHL. Patients ordinarily underwent radiotherapy five days a week. In the 94 cases treated, the higher success rate with the high dose (78%, against 61% for the low dose) was not statistically significant. (BBB)

4640 PRACTICAL VALUE OF A PHARMOCOLOGICAL METHOD OF ELIMINATION OF COLIC GASES IN ABDOMINAL RADIODIAGNOSIS. De Vecchi, A.; Musumeci, R. (Univ., Milan). Minerva Radiol., Fisioterap. Radiobiol., 12: 104-8 (Apr. 1967). (In Italian).

The pharmacological association of extract of posthypophysis and prostigmin is proposed as a practical method for eliminating colic gases in cases where normal preparation for radiological examination of the abdomen does not give a satisfactory result. This method was personally used with success in most cases. (auth)

4641 DETECTION OF HEPATIC SHUNTS BY THE USE OF ^{131}I-MACROAGGREGATED ALBUMIN. Ueda, Hideo; Kitani, Kenichi; Kameda, Haruo; Yamada, Hideo; Ito, Masahiro (Tokyo Univ.). Gastroenterology, 52: 480-7(Mar. 1967).

In the development of a new method for the measurement of flow in the extrahepatic and intrahepatic shunts in cirrhosis of the liver, simultaneous external monitoring of the radioactivities over the liver and lung and scintiscanning were performed following a single percutaneous injection of ^{131}I-macroaggregated albumin (MAA) into the spleen. When MAA with particle size ranging from 20 to 50 μ was injected into the spleen, it was almost completely trapped by the hepatic capillaries to which it was first delivered. In the presence of abnormal collateral vessels which bypass the hepatic sinusoids (either intra- or extrahepatic shunts), some of the injected MAA entered the systemic venous system, where it was trapped in the pulmonary capillaries. Twenty-five scintigrams over the liver and lung were obtained in 23 patients immediately after the injection of ^{131}I-MAA (300 μCi in a volume less than 1.0 ml) into the spleen. Conventional scintiscanning also was performed using ^{198}Au. Three patients with hemolytic anemias, 4 with hepatitis, and 2 with cirrhosis had no shunts. Shunt indices calculated from liver and lung counts in scintigrams ranged from 18 to 90 in patients with cirrhosis of the liver with shunts and below 6 in patients without shunts. An initial hump of the liver MAA accumulation curve was observed in 7 cirrhotics, suggesting the presence of intrahepatic shunts. Use of ^{131}I-MAA was considered to be an easy and useful method for the detection and semiquantitation of intra- and extrahepatic shunts in cirrhosis of the liver. (BBB)

4642 CARE OF INJURED ON AIRFIELDS FOLLOWING NUCLEAR ATTACKS. Risavi, A. Vazduhoplovni Glas., No. 3, 300-5(1966).

The fact is emphasized that in a future war, nuclear weapons may be the main weapons used. The kind of casualties, in general, one may expect under such circumstances are discussed and relative estimates of the amount of casualties one would encounter during strikes with bombs of varying sizes are presented. Results are then specialized for the case of airfields, and a brief account is given of the best use of available airfield medical personnel. (ATD)

4643 TWO ADDITIONAL CASES OF MULTIPLE MYELOMA IN ATOMIC BOMB SURVIVORS. Ishimaru, Michito (Nagasaki Atomic Bomb Hospital); Yasubi, Susumu; Danno, Hachiro; Oochuru, Sinn; Kubo, Minoru. Nagasaki Igakkai Zasshi, 40: 608-11(Aug. 1965). (In Japanese).

Since September 1964, 17 cases of multiple myeloma were diagnosed in Nagasaki. Among these, 8 cases concerned atomic bomb survivors. Distances from the hypocenter of the detonation were 1.0, 1.37, 3.5, and 3.37 km in 4 cases and 2 km in 4 others. The paraprotein was a β-globulin in 4 cases and γ-globulin in 3. Six cases were reported previously and the other 2 cases are reported here. Case 1 was that of a 60-yr-old female, exposed proximally to the atomic bombing. In June 1958, she complained of chest pain, back ache, and visited the hospital. The main symptoms at that time included anemia and chronic nephritis. The blood examinations showed erythrocytes at 1,580,000/mm^3, hemoglobin 37%, leukocytes 2800/mm^3, plasma Fe 68 μg%, Na 138.7, K 4.8, Cl 129.8 mequiv/l, and a low platelet level. Hepatic function was normal. Treatment of anemia by folic acid, vitamin B_{12}, and ACTH was not effective and it was only slightly improved after blood transfusions. Case 2, a 76-yr-old male, was exposed to the atomic bomb explosion at a distance of 1 km from the hypocenter. At that time bleeding and traumatic injury were observed. Recent examination at the time of visit to the hospital showed proteinuria, erythrocytes 2,120,000/mm^3, hemoglobin 48%, leukocytes 6100/mm^3, plasma Na 140, K 3.8, Cl 106.5 mequiv/l, Fe 124 μg%, and blood residual nitrogen 30 mg%. The anomalous serum protein in this case was a β-globulin; in the first case mobility of the protein was not ascertained. (BBB)

4644 5-FLUOROURACIL (NSC-19893) COMBINED WITH ^{60}Co TELETHERAPY IN TREATMENT OF BLADDER CANCER: PRELIMINARY REPORT. Kaufman, Joseph J. (Univ. of

California, Los Angeles); Stein, Justin J. Cancer Chemother. Rep., No. 48, 65-71 (Oct. 1965).

The five-year survival rate for invasive bladder carcinoma after cystectomy or supervoltage irradiation alone was found to be very low, and the mortality rate from surgery performed after 6000 to 7000 R of supervoltage irradiation was significantly greater than that of surgery alone. The former may be decreased by lower doses of radiation with less therapeutic efficacy. Although 5-fluorouracil (5-FU) produced remissions in patients with bladder cancer, it was rarely, if ever, curative. Clinical evidence for the synergistic effect of chemotherapy with 5-FU on ^{60}Co γ irradiation was sought in 27 cases of bladder cancer. Side-effects and complications of radio- and chemotherapy are reported. Doses of 2000 to 6000 R of radiation were used, depending on the 5-FU dose. Twelve patients with stage A, B, and C bladder carcinoma were apparently tumor free at 18 to 37 months. Four patients who had undergone radiotherapy prior to this treatment did not respond. When combination therapy was followed by cystectomy, no increase in surgical morbidity was noted. Complications occurred in the following percentage of patients: severe diarrhea 4, severe hematuria 15, mild diarrhea 52, nausea 48, stomatitis 4, erythema 4, peripheral leukocyte depression below 5000 cells/mm^3 48%. (BBB)

4645 PROGRESS IN SPLEEN SCANNING. Rosenthall, L. (Montreal General Hospital). J. Can. Ass. Radiol., 19: 338-41 (June 1967).

Of the four radiopharmaceuticals used for spleen scanning, viz., heat altered erythrocytes—^{51}Cr, mercurihydroxypropane-altered red cells, radiogold, and ^{99}Tc labelled sulfur colloid, the latter was found to give good scans most consistently. It is associated with the least whole body radiation exposure and excellent counting statistics. Spleen size, location and space occupying disease such as infarcts, tumors, are readily determinable. (auth) (Canada)

4646 THE USE OF π-NEGATIVE MESONS AND HEAVY IONS IN THE RADIANT THERAPY OF NEOPLASTIC PROCESSES. Bagni, B.; Pistocchi, G. F. (Univ., Ferrara, Italy). Minerva Radiol., Fisioterap. Radiobiol., 12: 179-89 (1967). (In Italian).

Beams of heavily ionizing radiations are considered, with a view to their eventual use in radiotherapy. Beams of heavy ions and negative pions are compared with beams of current use (^{60}Co γ rays and x rays). The physical properties of negative pion beams show that they may give an excellent distribution of dose with depth and a very favorable oxygen enhancement ratio. (auth)

4647 LASER RADIATION FOR BASAL CELL CARCINOMA. McGuff, P. E. (Laser Medical Research Foundation, Boston). Dermatologica, 133: 379-83 (1966).

The effect of ruby laser radiation on 3 human basal cell carcinomas is described, and its therapeutic effectiveness in 12 patients with malignancies is reported. The first irradiated basal cell carcinoma received six bursts of 146 J of ruby laser energy and then five bursts of 100 J to a wider area. The lesion underwent rapid progressive regression and complete dissolution. At 5½ months later histologic examination showed no malignant cells. The second carcinoma received 50 bursts of ruby laser energy of 150 J to a 1-mm dia focused spot, at an energy density of 15,000 J/cm^2. The total energy received was 7500 J. Four months post-laser histologic examination showed no malignant cells. The third lesion was given 14 bursts of 180 J each of ruby laser energy, and on the 36th post-laser day histologic examination showed a 2-mm area of basal cell carcinoma. Laser energy was again used to deliver 17 bursts of 146 J to the lesion. The lesion rapidly healed, and no tumor cells were seen at 5½ months post-laser. Use of laser and ionizing radiation to eradicate skin tumors is compared. It is suggested that laser radiation may be more effective and that it avoids the subjacent tissue necrosis that may accompany ionizing radiation therapy. (BBB)

4648 HYPERBARIC OXYGEN AND RADIOTHERAPY OF A FIBROSARCOMA AND OF A SQUAMOUS-CELL CARCINOMA OF C_3H MICE. Suit, H. D.; Suchato, C. (Anderson Hospital and Tumor Inst., Houston, Texas). Radiology, 89: 713-19 (Oct. 1967).

Radiation dose-tumor control response assays were presented for a fibrosarcoma and squamous cell carcinoma, studied as transplants in $(C_3H/He \times C_{57})F_1$ hybrid mice. X radiation was administered either as a single dose or as 10 equal doses with 24 hr intervals between treatments; conditions at irradiation were either hypoxia, air or normal; or O_2 30 psi. Effectiveness of treatment administered in a single radiation dose was modified only slightly by respiration of oxygen at 30 psi for fifteen minutes prior to treatment. However, for the fractionated irradiation, respiration of oxygen at high pressure was markedly effective in increasing tumor cure probability. Results from these studies and from earlier studies on a C_3H and a DBA mouse mammary carcinoma are reviewed. (auth)

4649 LYMPHATIC DISEASES OF ATOMIC BOMB SURVIVORS IN NAGASAKI. Itoka, Takasi (Nagasaki Univ.); Oka, Songo; Toyoda, Shigeki; Ichimaru, Michito. Nagasaki Igakkai Zasshi, 40: 616-19 (Aug. 1965). (In Japanese).

A total of 229 cases of lymphatic diseases of atomic bomb survivors in Nagasaki observed from August 1945 to July 1964 was studied. During the past 19 yr the lymphatic diseases diagnosed among atomic bomb survivors in Nagasaki included lymphosarcoma 43 cases (18.8%), reticulosarcoma 81 cases (35.4%), giant follicular lymphoma 5 cases (2.2%), and leukosarcoma 12 cases (5.2%). A correlation between the incidence rate and the distance from the hypocenter was shown. On the bases of cases per 1,000,000 population, within the radius of 1999 m the incidence rate in atomic bomb survivors was 36.2, between 2000 and 9999 m distances 28.0, and between 0 and 9999 m distances 28.7. In contrast, the incidence rate in the nonatomic bomb survivors was only 16.8 cases per million population. The mortality rate for the diseases was also studied. Among 1,000,000 population, there was 9.46 fatal cases in 1950, 10.84 in 1952, 11.8 in 1954, and 12.61 in 1956; that is, the mortality rate increased in the later years. The incidence rate of malignant lymphoma in Nagasaki in proximally exposed (<2000-m radius) atomic bomb survivors increased since 1945 and reached a maximum in 1950-1951. After that the incidence gradually decreased. On the other hand, the incidence of leukemia among non-atomic bomb survivors gradually increased from 1956 and reached a maximum in 1957. Incidence of lymphosarcoma had increased among the atomic bomb survivors as well as controls since 1957. The average survival period for patients with the lymphatic system diseases was as follows: Hodgkin's disease 8.5, reticulosarcoma 6.1, and leukosarcoma 4.9 months, and lymphosarcoma 4.5 months. (BBB)

4650 TREATMENT OF PSORIASIS VULGARIS BY MEANS OF LARGE FIELD UV IRRADIATION. Forck, G. Arch. Klin. Exp. Dermatol., 227: 267-9 (1966). (In German).

The effect of whole-body uv irradiation on psoriasis by use of a large radiation source was studied. In order to provide a high intensity, large-field uv source a 2-m long 75-cm wide, and 45-cm high metal chamber was constructed. It contained 8 uv lamps of the uv 1800 type, arranged along the central axis of the reflector housing. The lamps were located ~15 cm apart. The field size of the equipment was large enough to provide whole-body irradiation of one side of a patient easily. The reflector was constructed of polished Al, in a parabolic shape, so that most of the irradiated light was reflected in parallel beams perpendicularly onto the patient. The results of treatment with this equipment so far were good, although the number of patients treated was, statistically, small. The scaly eruptions healed very well, treatment time required was decreased, and the patients were more comfortable during treatment. (BBB)

4651 RADIOTHERAPY: ART AND SCIENCE 1965. D'Angio, G. J. (Univ. of Minnesota, Minneapolis). J.-Lancet, 87: 256-8 (July 1967).

Radiobiologic bases of radiotherapy are examined, with emphasis on effects of ionizing radiation on normal and malignant cells. Effective radiotherapy depends on the relative insensitivity of the normal cell as compared with radiosensitivity of the abnormal, neoplastic cell. This so-called therapeutic ratio in the pediatric patient is narrow. Deleterious effects of irradiation in children can be immediate and obvious, or they can be long delayed and extremely subtle. In the first category are bone growth disturbances. Modest doses of irradiation given to the infant may seriously disrupt normal bone growth leading to shortening of a limb, asymmetrical growth, or similar orthopedic problems. These can sometimes be avoided entirely, or at least lessened, by use of lead blocks interposed between the treatment beam and the growth centers. The long-delayed effects of irradiation, however, are often insidious in onset and difficult to predict. They include oncogenesis and functional impairment. Several examples of deleterious effects are described to indicate that irradiation cannot be employed randomly in the treatment of malignant disease. They demonstrate a need of perfecting techniques so as to obtain better effects in the tumor while lessening the reactions in normal structures. Enhancement of radiation effects by oxgenation of tissues and differential effects of different types of ionizing and heavy-particle radiation are also reviewed. (BBB)

4652 MALIGNANT DISEASE IN THE ATOMIC BOMB SURVIVORS. Yasuhi, Sasumu (Nagasaki Atomic Bomb Hospital); Chifu, Michusabro; Tanaka, Tosikazu; Alitomi, Tadao; Machukuma, Genichiro; Oochuru, Shin; Uchida, Yuzo. Nagasaki Igakkai Zasshi, 40: 603-7 (Aug. 1965). (In Japanese).

The frequency, site, and pathologic classification of malignant

diseases in atomic bomb survivors observed in the Nagasaki Atomic Bomb Hospital during the past six years were compared with data from autopsy reports from the whole of Japan. From May 1958 to August 1964, there were 283 autopsies among atomic bomb survivors. Not counting leukemia, there were 143 cases (50.5%) of malignant diseases. The incidence of malignancy according to sex was for males 47.6% and for females 54.8%. These results were compared with those for 53,339 autopsy cases in Japan from January 1958 to December 1962, and it was found that besides leukemia there were 19,682 cases (36.9%) of malignant diseases in Japan. Thus, the frequency of malignant diseases among the atomic bomb survivors was higher than that of the whole of Japan. Furthermore, if nonautopsy cases were also counted, the proportion of mortality from malignant diseases in atomic bomb survivors was 49.2%, about the same as in the autopsy cases. Classification of malignant diseases in the survivors was as follows: stomach cancer 44 cases (30.8%), hepatic cancers 25 (17.4%), malignant lymphatic tumors 19 (13.28%), lung cancers 11 (7.7%), gall bladder cancers 9 (6.3%), bone marrow tumors 6 (4.2%), thyroid cancers 5 (3.5%), uterus, large intestine, and breast cancers 4 cases each (2.8%), spleen cancer 3 (2.1%), ovary cancer and bone tumor 1 case each (0.7%). In comparison with the autopsy reports with those from the whole of Japan, the atomic bomb survivors showed a higher incidence of hepatic cancer, malignant lymphatic tumor, bone marrow tumor, and thyroid cancer. (BBB)

4653 SKIN INJURIES IN ATOMIC EXPLOSIONS. Rosenkranz, Helmut (Hautklinik der Bezirkskrankenhauses, Potsdam, Ger.). Z. Aerztl. Fortbild., 59: 1067-70(Oct. 1, 1965). (In German).

Various types of primary, secondary, and late skin injuries that have resulted from irradiation emitted from atomic explosions are briefly reviewed. A tabulation of the comparative symptoms of irradiation, with indications of their chronological incidence and duration, is presented. These include nausea, diarrhea, stomatitis, pharyngitis, fever, epilation, skin injuries, effects on blood and bone marrow, and icterus. Therapeutic measures for treatment of skin injuries include use of sterile bandages, debridement, disinfection, and cleansing with physiological saline and soap solutions are recommended. Severely contaminated wounds should be cleaned with H_2O_2. Use of powders and salves is contraindicated. Exudative radiation injuries should be treated with antibiotic salves, vaseline, and prednisone. (BBB)

4654 BRAIN SCANS OF CEREBRAL INFARCTS WITH RADIOACTIVE MERCURY. Glasgow, Joseph L.; Currier, Robert D.; Goodrich, Jack K.; Tutor, Forrest T. (Veterans Administration Center, Jackson, Miss. Univ. Medical Center, Jackson, Miss.). Radiology, 88: 1086-91(June 1967).

An analysis of 179 brain scans obtained in 152 cases of cerebral infarction. Lesions judged to be large by clinical methods gave a high percentage of positive scans with a peak of 95 percent positive during the second and third weeks after infarction. The clinically small lesions were much less likely to show during the same period. A delay between the time of infarction and the appearance of the lesion on the brain scan was demonstrated. Hemorrhagic infarcts became positive earlier than anemic infarcts. Examples of infarcts in the anterior, middle, and posterior cerebral and the cerebellar artery territories are illustrated. The majority of the abnormal brain scans have characteristics helpful in the differentiation from neoplasm, and the value of a repeat scan for this purpose is demonstrated. (auth)

4655 OPHTHALMOLOGICAL STUDIES ON THE INFANTS OF ATOMIC BOMB SURVIVOR MOTHERS IN NAGASAKI. Kawamoto, Sadahisa; Hujino, Tadashi; Hujisawa, Hideo (Atomic Bomb Casualty Commission, Nagasaki). Nagasaki Igakkai Zasshi, 40: 632-7(Aug. 1965). (In Japanese).

An ophthalmological survey was conducted on the 184 infants from atomic bomb-exposed mothers and 82 controls. The visual acuity of the subjects was examined by having the subject read a Snellen chart and then examination with a Welch Allyn instrument. The observed heterochromic irides, pigment spots, crystalline lens opacity, and abnormal pupil membranes were examined with an eye-piece micrometer and biomicroscope. Disturbances in visual acuity were found in 71 cases, with values of 20/70 or worse. However, there was no significant difference in visual disturbances between atomic bomb survivor and nonsurvivor groups. When hyperchromic and hypochromic irides and pigment spots were examined in both eyes of patients, 15 to 17% of the investigated subjects showed heterochromic irides; segmental heterochromic irides were not observed. The incidence of pupil disturbances in infants from bombing survivors was higher than that of controls. There were 32 cases with lens opacity and 15 cases showed it in both eyes. There was no correlation between eye disorders and the exposure distance from the hypocenter. The frequency of disturbances of visual acuity in the infants from atomic bomb survivors was 23.0 to 25.0%, which was lower than that of high school students (16 to 18 years of age) for the whole of Japan (their incidence of nearsightedness was 32.8 to 34.4%). The incidence of heterochromic irides in bombing survivors (15 to 17%) was much higher than that for the entire population of Japan (3.8%). (BBB)

4656 IMPORTANCE FOR RADIOPROTECTIVE EFFECT IN MAMMALS OF PHARMACOLOGICAL AND BIOCHEMICAL ACTIONS OF CYSTEAMINE AND RELATED SUBSTANCES. Bacq, Z. M. (Univ., Liege).; Beaumariage, M. L.; Van Caneghem, P.; Ciccarone, P. Ann. Ist. Super. Sanita, 1: 639-45(1965). (RT/BIO-(66)14).

The two main classes of radioprotective compounds: those acting by inducing anoxia and the SH and S-S protectors, many of which are not anoxiating, are discussed in relation to their mode of action. The chemical form, concentration, and time that the protector is most effective; effect of animal species; and the cytological effects of radioprotective doses are included. The protective effects of AET, cystamine, and cysteamine against the lethal effects of x radiation for rats and mice are compared and discussed. (B.H.S.)

4657 PROTECTIVE EFFECTIVENESS OF SOME SULFUR-CONTAINING SUBSTANCES AND OXYGEN UPTAKE IN THE RAT. Betz, E. H.; Lelievre, P.; Smoliar, V. (Univ., Liege). Int. J. Radiat. Biol., 12: 163-8(1967).

The radioprotective effects of beta-mercaptoethanol, cystamine, and cysteine were studied in rats exposed to whole-body x radiation (900 R) at various delays after administration of the compound. Two minutes after the injection of cystamine or cysteamine, the protection was poor; a steep increase of activity was observed between the second and tenth minute. At 20 and 30 min, the effectiveness remained unchanged or dropped slightly; the best protection was obtained 45 min after the injection. In this strain of rats, cystamine was more effective than cysteamine. For cysteine, there was also an increase of the activity between 2 and 10 min, but the protection was rather low and remained unchanged from the 10th to the 90th minute. Beta-mercaptoethanol had no protective activity. Cystamine, cysteamine, and cysteine decreased the oxygen uptake. The maximum effect was found 10 min after the injection. Later on, there was a progressive recovery of the oxygen utilization. Beta-mercaptoethanol had no depressive effect on the oxygen uptake. The correlation between oxygen uptake and protective effectiveness is discussed. (auth)

4658 ON THE POSSIBLE PATHWAY OF REALIZATION OF THE PROTECTIVE EFFECT OF RADIOPROTECTORS. Akoev, I. G.; Lagun, M. A.; Ognev, B. I.; Ziadinova, O. F. Radiobiologiya, 6: 891-7(1966). (In Russian).

The general mechanisms of the protective effects of radioprotectors were studied in experiments on mice and rats, subjected to ^{60}Co γ irradiation using cydoxin (cystamine with pyridoxine in a 3:1 ratio by weight) as the radioprotector (intraventricular injection 20 to 30 min before irradiation in a dose of 400 mg/kg). In one experiment mice were irradiated at doses up to 600 R, and an exponential dependence of the change in the relative weight of the spleen upon the irradiation dose was obtained. A definite influence of radiation dose on the radioprotective effect of cydoxin was also observed. The radioprotective effect was least at the doses where the greatest rate of repair of radiation damage was observed without the radioprotector; at the radiation doses for which the rate of postirradiation recovery was the lowest, an increase in the radioprotective effect was observed. In another experiment, the possibility of reducing the residual radiation injury was studied on mice irradiated at a dose of 600 R ($LD_{14/30}$) and subjected to the repeated influence of various doses of radiation after eight days. Administration of cydoxin before the first irradiation substantially reduced the residual radiation damage eight days after irradiation. The effectiveness of the radioprotector for various doses of irradiation was studied in an experiment on rats. Cydoxin was found to promote a decrease in the residual radiation damage for all doses used (up to 600 R). The question of whether the radioprotector actually significantly reduces the primary radiation injury or acts only through acceleration of the recovery processes was studied in white mice irradiated at a dose of 750 R or infected with Bacillus perfringens toxin. The resistance to repeated irradiation or infection with bacterial toxin was no less impaired in the animals that received the radioprotector before irradiation than in the intact mice. This result was compared with clinical material from the literature. It was concluded that the possible mechanism of the protective action of radioprotectors may consist of an acceleration of the repair of radiation damage during the process of irradiation and an increase in the fraction of radiation injuries that have time to be repaired during the radiation influence, no matter how short the interaction of radiation with the biosubstrate may be. (JPRS)

4659 RESTORING EFFECT OF A HETEROLOGOUS DESOXYRIBONUCLEIC ACID IN AXENIC MICE WHICH HAVE RECEIVED A LETHAL DOSE OF X RAYS. Ducluzeau, R.; Salomon, J. C.; Vendrely, C. (CNRS, Villejuif, France). Compt. Rend. Soc. Biol., 161: 70-3(1967). (In French).

The radiorestoring capacity of a heterologous DNA in axenic mice (mice without intestinal bacterial flora) was investigated. Mice of the line C 3H were irradiated at doses of 700, 650, and 620 R. In a first series the animals received DNA injection within one hour after irradiation and a daily dose for the next five days. In a second series the mice received a single injection within 30 min. after the irradiation. In the first series no radioprotective effect by the DNA was observed. In the second series survival of 21 to 25% was observed. In all the experiments the females were more radioresistant than the males. The results confirm in the axenic animal the radiorestoration effects of DNA. (J.S.R.)

4660 ENHANCEMENT OF REGIONAL BLADDER MEGAVOLTAGE IRRADIATION IN BLADDER CANCER USING LOCAL BLADDER HYPERTHERMIA. Cockett, A. T. K.; Kazmin, Marvin; Nakamura, Robert; Fingerhut, A.; Stein, Justin J. (Harbor General Hospital, Torrance, Calif.). J. Urol., 97: 1034-9(June 1967).

In view of the generally poor results of radiotherapy in invasive carcinoma of the bladder, attempts were made to develop a method for enhancing radiosensitivity. Findings in the canine bladder after locally irradiating it under a variety of environmental conditions are reported. The bladder was heated to 42 to 44°C, cooled to 15°C, or kept at body temperature during irradiation with a 6-MeV linear accelerator, at ~200 R/min, for doses of 500, 1000, and 1500 R. The histopathological findings in a bladder subjected to hyperthermia (47°C) for 30 min were noted. Sloughing of the mucosa was present and the submucosa was markedly edematous. Thrombosis of small blood vessels had occurred. To study the effects of 1500 R on the canine bladder at 3 different temperatures, biopsies were obtained 24 to 27 days after combined treatment. In bladders of dogs receiving 1500 R and hypothermia some denudation of mucosa was present and minimal hemorrhage in the submucosa was seen. Thrombosis of small blood vessels was also present. Mild early granulation tissue response was demonstrated. In bladders of dogs receiving 1500 R and normothermia, some swelling with vacuolation of epithelial cells was present. New capillaries could be seen in the edematous submucosa. Fibrous loose connective tissue dominated this layer. In bladders of dogs receiving 1500 R and hyperthermia, destruction of the epithelium was present. The mucosa was swollen and vacuolation of cells was noted. Thrombosed blood vessels and new granulation tissue were dominant features. Results were compared when canine bladders received 1000 R plus hypothermia and 1000 R plus normothermia. In biopsies obtained 28 days following combined therapy, denudation of the mucosa was a common feature. Increased fibrous tissue formation with telangiectasia was present in the animal's bladder heated during irradiation. Enhancement of the radiation effect by maintaining an elevated temperature of tissue was apparent. The effect of elevated temperature is probably mediated by an increased tissue oxygen tension and increased mitotic rate of the heated tissue. (BBB)

4661 IRRADIATION, RADIOPROTECTION ET SYNTHESE DE L'ACIDE DESOXYRIBONUCLEIQUE. (Irradiation, Radioprotection, and Synthesis of Desoxyribonucleic Acid). Goutier, Roland. Collection Medico-Monographies d'Agreges. Brussels, Editions Arscia S.A., 1967. 238p.

As the physiological role of acid DNAase is poorly understood, experimental results on the relation between the activity of acid DNAase and the rapidity of growth in regenerating liver are reported. The behavior of acid DNAase in the different tissues of irradiated rats is examined. The biosynthetic alterations of DNA and RNA, as well as of the enzymes which catalyze them (kinases and poylmerases), in the regenerating liver are examined. The effect of chemical radioprotectives such as cysteamine, 2-β-aminoethylisothiourea, and AET on the different enzymes studied in the spleen and regenerating liver are discussed. (J.S.R.)

4662 THERAPEUTIC METAL SEED CONTAINING WITHIN A RADIOACTIVE ISOTOPE DISPOSED ON A CARRIER AND METHOD OF MANUFACTURE. Lawrence, Donald C. (to Hazleton-Nuclear Science Corp.). U. S. Patent 3,351,049. Apr. 12, 1965.

A radioactive seed for use in radiation therapy of tissue comprising a sealed container having an elongated cavity therein and constructed with walls of substantially uniform thickness, a therapeutic amount of soft x-ray emanating radioisotope disposed within the cavity, and soft x ray emanating isotope having a characteristic radiation substantially all of which lies between about 20 keV and 100 keV and being essentially free from alpha and beta radiations and higher energy x-ray and gamma radiations, the isotope having a half-life from about eight to 100 days, and means disposed within the cavity for maintaining the radioisotope in a substantially uniform distribution along the length of the cavity, the last named means being made of a material selected to have low absorption for soft x rays to thereby minimize internal absorption, the container including walls being made of a metal selected to have a relatively low atomic number to thereby minimize the absorption of soft x rays while completely containing the isotope, the metal being further selected to be nontoxic and nonsoluble in the tissue being treated. A method for making a therapeutically radioactive seed comprising soaking a nylon carrier body of an organic polymer in a solution containing the radioactive iodine isotope ^{125}I so that the body contains a therapeutic amount of the ^{125}I, then placing the body axially inside of a stainless steel tube, and fusing the ends of the tube to seal it. (auth)

Radiation Effects on Animals

Refer also to abstracts 4565, 4566, 4569, 4572, 4573, 4577, 4579, 4589, 4590, 4603, 4611, 4612, 4618, 4619, 4631, 4635, 4636, 4639, 4643, 4648–4656, 4658, 4661, and 4725.

4663 (AED-C-04-30) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK, SEKTION 04: STRAHLENWIRKUNG AUF LEBENDES GEWEBE UND ORGANISMEN. (Bibliographies in Nuclear Science and Technology. Section 04: Radiation Effects on Living Tissues and Organisms). Stahlhofen, W. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). July 1967. 125p. (In several languages). Dep.

A bibliography is presented of radiation effects on living tissues and organisms. The bibliography is comprised of titles from conferences, dissertations, patents, reports, journal literature and books. There are also author, report, and subject indexes. (J.S.R.)

4664 (BNWL-SA-571) THE MEEK SHALL INHERIT THE EARTH. Erdman, H. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 4, 1966. Contract AT(45-1)-1830. 28p. Dep. CFSTI.

Radiations are recognized environmental constituents. Increased radiations resulting from military, industrial, medical and research uses today involve greater numbers and kinds of organisms. The need exists to determine the effects of radiations on individual performance, population dynamics, and community structure. Background radiations might adversely affect man, his natural resources, and his agricultural practices when considered in combination with other environmental variables. Therefore, the synergistic or antagonistic response(s) between radiation and physico-chemical factors require definition and clarification. The hypothesis that insects are the meek that will inherit the earth is developed from the standpoints of physiology, morphology and especially resistance to radiations. Strains and species of flour beetles having similar ecological requirements were used for the radioecological studies discussed. Radiation tolerances of various life cycle stages are discussed in terms of development and differentiation. Alterations from radiations during early productivity were correlated with sexual maturity. Lethal effects of x-ray on male and female germ cells simulated genetic dominant effects. Population performance is described for single and/or mixed species populations that were subjected to various x-ray doses and temperatures. Competition adds ecological realism in the mixed species populations. Modifications of mortality and productivity in populations of species and strains were determined when the stresses, x-radiation and the insecticide, DDT, were applied singly or in combination. Reproductive performance of populations of mutant flour beetles (black body color) was better in environments containing both stresses than in those containing one stress only. This finding with its important applications in radiation ecology, economic entomology and evolution supports the eventual Age of Insects. (auth)

4665 (USNRDL-TR-67-95) EFFECTS OF DOSE AND OF PARTIAL-BODY EXPOSURE ON CONDITIONING THROUGH A RADIATION-INDUCED HUMORAL FACTOR. Hunt, Edward L.; Carroll, Harold W.; Kimeldorf, Donald J. (Naval Radiological Defense Lab., San Francisco, Calif.). Aug. 3, 1967. 20p. CFSTI.

X irradiation (360 R) of one member of a parabiotic rat pair (united by skin-vascular anastomosis) can serve to motivate a conditioned aversion to saccharin-flavored fluid in its completely-shielded partner. The induction of a circulating humoral factor that acts as a noxious stimulus was investigated further in the parabiotic preparation. The degree of conditioning of a saccharin aversion in the shielded partner was significantly reduced with

exposure of the irradiated member to a lower dose of 180 R. No evidence of conditioning was obtained when the irradiated member was exposed to 180 or 360 R when the head or the remainder of the body was shielded. It was concluded that induction and transfer of the humoral factor resulted from effects produced in both regions of the body and is not related simply to the mass of tissue exposed. Loss of the effectiveness of irradiation in the exposed member, because of circulatory pooling of the humoral factor with the shielded partner, was also investigated. A marked conditioned aversion to saccharin was obtained in the irradiated member with a 12 R exposure only when its partner was equally exposed and dilution by pooling was precluded. It was concluded that a 12 R exposure induced a humoral factor which was diluted by circulatory pooling with a shielded partner. (auth) (CFSTI)

4666 SOMATIC AND GENETIC EFFECTS OF IONIZING RADIATIONS. Paterni, Ludovico (Univ., Rome). Securitas, 51: 47-63(May 1966). (In Italian).

The main causes of human exposure to ionizing radiations, their pathogenic mechanisms, and their precocious or delayed, experimental or human, genetic and somatic effects are reviewed. From the human standpoint, such effects are considered in connection with disorders of the haemopoietic apparatus, malignant tumors, skin and ophthalmic diseases. Disorders of the hemopoietic apparatus are more fully dealt with and compared to haemopathic disorders of an exogenous toxic nature. Some brief practical considerations are expressed with reference to prevention. (auth)

4667 RADIATION INJURY AS A TUMORIGENIC FACTOR. Nehls, K. (Univ., Griefswald, Ger.). Z. Laryngol., Rhinol., Otol., 44: 648-60(Oct. 1965).

Tumor formation may be induced by trauma in various forms. One of these is irradiation injury which may affect cell nuclei. Various aspects of the poorly understood processes induced by irradiation that may cause tumor formation are discussed by the author. The four criteria that may be used to relate exposure to ionizing irradiation to tumor formation are histological evidence of benign primary disease, high dose of irradiation, long latent period between primary irradiation and the onset of the secondary disease, and histological proof that the second disease is a malignant tumor. Four cases are reported of patients who had received irradiation 20, 15, 17, and 42 yr previous to admission, who later developed malignant disease. Of these four, two satisfied the four criteria regarding induction of irradiation tumors. In the third case the laryngeal carcinoma developed after treatment with x irradiation of undeterminable dose; it could not be eradicated with x irradiation, Co therapy, nor surgery. In the last case a sarcoma developed after extensive irradiation of lupus of the face with considerable doses of x irradiation and uv irradiation. In another case consisting of an anaplastic lung carcinoma, recurrence of the lupus of the face also developed. The author favors surgery for removal of irradiation tumors. (BBB)

4668 RADIOLOGY IN OBSTETRICS. Varadarajan, M. G. (Madras Medical Coll.). Indian Pract., 19: 249-55(Mar. 1966).

Possible hazards to mother and fetus of diagnostic x-ray examinations in pregnancy are evaluated, and protective measures are ennumerated. It is pointed out that clinicians can provide reliable biological tests and that there is rarely any justification for seeking radiological confirmation of normal pregnancy in its early stages. Any x-ray examination in the earlier weeks of pregnancy must have a strong justification since the time when radiation is most likely to cause fetal damage is during the first few weeks. Radiological examinations of the urinary and alimentary tracts and chest should, whenever possible, be avoided during pregnancy. Experts in the field agreed that obstetric radiology, carefully conducted, has far more to offer in the immediate and ultimate interests of mother and child than the deliberate withholding of radiological examination because of radiation hazards. (BBB)

4669 SARCOMA: A POSSIBLE LATE RESULT OF EFFECTIVE RADIATION THERAPY FOR PITUITARY ADENOMA. REPORT OF TWO CASES. Waltz, Thomas A.; Brownell, Betty (Radcliffe Infirmary, Oxford). J. Neurosurg., 24: 901-7(May 1966).

Case records revealed three cases of fibrosarcomas that developed in the path of the beam after x-ray treatment of pituitary adenomas. Two of these cases are described in detail. In the first case, that of a 38-yr-old man, x-ray therapy was given postoperatively. The calculated dose to the tumor was 3500 R given in 21 treatments over a 3-½-week interval. Rotational therapy was used with 250 kV and a half value layer of 1.5 mm of Cu. Five years later a sarcoma in the tentorium was diagnosed. In the second case, a sarcoma was noted in the frontal lobe eight years after treatment of a 3-yr-old girl with an undetermined dose of x rays. Severe skin damage occurred in the second case. Eight additional cases reported in the literature are reviewed, as well as general aspects of the subject. Multiple courses of radiotherapy appeared to increase the risk of developing sarcoma. An explanation of occurrence of a high proportion of sarcomas was that pituitary adenomas are benign tumors and that the patients have a long survival. (BBB)

4670 ANIMAL EXPERIMENTS IN THE STUDY OF RADIATION INJURY TO THE GROWING TEMPOROMANDIBULAR JOINT. Weiss, Peter (Univ., Erlangen-Nuremberg, Ger.). Deut. Zahnaerztl. Z., 22: 141-8(Feb. 1967). (In German).

Experiments were performed in rabbits aged 8 to 12 weeks in which one temporomandibular joint of each was irradiated with 600, 1500, or 2500 R. Such irradiation resulted in marked inhibition of the growth of the ascending mandibular ramus and of the capitulum of the temporomandibular joint on the irradiated side. The mandibular bone was not affected. Histologically, the following changes were seen in the articular cartilage, which is considered the center of growth of the mandible. During the first weeks after irradiation the peripheral, proliferating layers of the articular cartilage showed reductions in number of cells and changes in nuclei as compared with the nonirradiated side. In the terminal stage, lesions were seen in the irradiated temporomandibular joint that pervaded the entire articular cartilage from the cartilage/bone limit up to the surface. Mechanisms of radioinduced growth disturbances in the ascending mandibular ramus due to irradiation of the temporomandibular joint and the importance of these findings for radiation therapy in this region are discussed. (BBB)

4671 RADIATION PNEUMONITIS. X-RAY INDUCED LESIONS IN HAMSTERS AND RATS. de Villiers, A. J.; Gross, Paul (Univ. of Pittsburgh). Arch. Environ. Health, 15: 650-9 (Nov. 1967).

Radiation pneumonitis as seen in the hamster was described and compared with that observed in the rat. There were notable differences with regard to the duration of the latent period between the acute initial changes and the delayed reaction and with regard to the severity of these reactions in the two species. In connection with the characteristic pathologic changes of radiation pneumonitis, two distinct cell types (plasmacytoid and mast cells) made their appearance. This suggested an immunological basis for the morphological appearances observed. The production of radiation-induced emphysema and the accumulation of eosinophilic proteinaceous material consistent with that found in alveolar proteinosis were described and illustrated. (auth)

4672 PIGMENTATION DUE TO PHENOTHIAZINES IN HIGH AND PROLONGED DOSAGE. Satanove, Abraham (Provincial Mental Hospital, Essondale, Can.). J. Amer. Med. Ass., 191: 263-8(Jan. 25, 1965).

Histochemical studies were made of the skin of patients exposed to uv light after receiving phenothiazine drugs to determine the nature of the pigment developing in the skin. It was found that 78 patients receiving abnormally high doses of chlorpromazine and related phenothiazine derivatives for prolonged periods developed pigmentary changes in the exposed areas of the skin after exposure to specific bands of sunlight. Histochemical studies suggested that this color was melanin or a melanin-like substance. The phototoxic action of uv light acting on the abnormal amounts of the phenothiazines in the skin produced an inflammatory response followed by increased production of melanin. The accumulation of melanin, or melanin plus chlorpromazine or its metabolites, was thought to cause the purple color. It is proposed that uv irradiation causes free radicals to develop from the phenothiazines, which have an absorption band at 2900 to 3100 Å, that then react with melanin. The capacity of melanin to protect human tissue against uv light may be related to the fact that melanin has the ability to capture or trap the free radicals generated in the skin, thus preventing them from exerting their harmful effects. Melanin, by trapping the blue or purple free radicals produced by exposure of chlorpromazine to uv light, is considered as the probable source of the additional color noted on the spectrophotometric studies. (BBB)

4673 FUNCTIONAL CHANGES OF THE ADRENAL GLAND AFTER SUPRALETHAL TOTAL-BODY IRRADIATION. Zsebok, Zoltan B.; Petranyi, Gyozo Jr.; Baumgartner, Edit; Fachet, Jozsef. Radiobiol. Radiother., 8: 201-8(1967).

Changes occurring in adrenal function of rats after supralethal irradiation were studied. After whole-body irradiation with 1300 R, they determined the corticosterone level of blood, and the corticosterone and aldosterone secretion in vitro of the adrenal glands. They have found that two phases took place in the hormone secretion of the adrenal gland, and that these phases were more marked in case of corticosterone. After irradiation, corticoste-

rone hypersecretion of an acute character took place; after this phase had passed, increased corticosterone production took place again by the 48th and 72nd hour. These two phases were not distinct in aldosterone production. Histological investigations largely supported the secretory changes noted. By way of conclusion, the disturbances of salt and water balance were correlated with functional changes of the adrenal gland. (auth)

4674 SELECTIVE DESTRUCTION OF PRECURSORS OF MICRONEURONS OF THE CEREBELLAR CORTEX WITH FRACTIONATED LOW-DOSE X RAYS. Altman, Joseph; Anderson, William J.; Wright Kenneth A. (Massachusetts Inst. of Tech., Cambridge). Exp. Neurol., 17: 481-97(Apr. 1967).

Doses of 2-MeV x irradiation needed to selectively destroy certain postnatally forming neural elements of the brain were determined. Two-week old kittens were irradiated unilaterally with 5 repeated doses, single doses ranging from 50 to 400 R, and the animals were killed on the 16th day. The effects of radiation were evaluated quantitatively on the irradiated and control sides in the ansiform lobule of the cerebellar cortex. Repeated doses of 50 to 100 R reduced the migratory cell population of the external granular layer; 150 R produced a subtotal, and 200 R a total destruction of the layer. With 150 R and higher doses the total area and the cell population of the internal granular layer of the ansiform lobule were appreciably reduced; with 200 R and higher doses the cell packing density of the granular layer was also affected. Irradiation with 150 R or higher doses reduced the ratio of granule cells to Purkinje cells. Although x irradiation up to 200 R had no effect on the control side, effects were produced with 300 and 400 R. The Purkinje cells were adversely affected only with 400 R. It was concluded that 200 R is the optimal dose in kittens for selective destruction of the precursors of the postnatally forming granule cells in circumscribed parts of the cerebellar cortex of kittens. (BBB)

4675 STUDIES IN LASER DESTRUCTION OF CHEMICALLY INDUCED PRIMATE HEPATOMAS. Mullins, Fitzhugh (Univ. of Louisville, Ky.); Hoye, Robert; Ketcham, Alfred S.; Kelly, Margaret G.; O'Gara, Roger W.; McKnight, William B.; Jennings, Buford. Amer. Surg., 33: 298-303(Apr. 1967).

Effects of neodymium laser radiation (10,600 Å) on liver tumors induced in monkeys by N-nitrosodiethylamine are reported. Energy output on target was 500 to 900 J, with a pulse duration of 2 msec. The laser beam was focused on a spot size of 5 mm in dia. The gross effect of these high energy pulses on the large, dense fibrotic tumor masses appeared minimally destructive. Microscopically some tumor cells showed nuclear distortion, hyperchromasia, spindling, and swollen nuclei. Laser irradiation did not appear to destroy the tumors readily. Instantaneous vaporization of the tumor tissue, such as occurred with neodymium irradiation of the Cloudman S-91 melanoma in mice was not seen. Small hepatoma nodules, measuring 1 cm or less, required 3 to 6 overlapping pulses of 700 to 900 J each to bring about complete destruction. The lack of pigmentation and fibrous consistency of the hepatoma in contrast to the dark color and soft consistency of transplantable tumors, such as the melanoma, may be important in this differential susceptibility. The hepatoma absorbed neodymium laser energy poorly because of its relative opacity and reflectivity. Direct impaction of large, laser-resistant masses of tumor in the liver resulted in tumor emboli in the lungs and implantation of viable tumor in the adjacent liver parenchyma. (BBB)

4676 INTERACTION OF LASER RADIATION WITH BIOLOGIC SYSTEMS. II. EXPERIMENTAL TUMORS. Klein, E.; Fine, S.; Laor, Y.; Simpson, L.; Ambrus, J.; Richter, W.; Smith, G. K.; Aaronson, C. (Roswell Park Memorial Inst., Buffalo). Fed. Proc., 24: Transl. Suppl. 14, 143-9(Jan.-Feb. 1965).

Pulsed laser radiation at 6943 and 10,600 Å was used at energy levels ranging from 10 to 900 J per pulse and up to 2000 J in total energy. The tumors studied were Harding Passey and Cloudman S91 melanomas, Ridgway osteogenic sarcoma, and Lewis bladder carcinoma. Transplants were carried out in various strains of mice. Delivery of 350 to 2000 J of energy, as 30 to 50 pulses at intervals of 1 sec (high pulse repetition frequency), resulted in severe trauma followed by death in less than 24 hr in most normal and tumor-bearing animals. Death was associated with severe lesions to adjacent normal structures rather than to effects on the tumor. Some tumor regressions were observed with total energies over 150 J delivered in fractionated doses at intervals of 24 hr, but not with less than 150 J. The frequency at which successive pulses were delivered had a significant effect in addition to the total energy and energy density. Failure to induce regressions in Cloudman S91 melanoma may have been related to metastatic dissemination enhanced by laser radiation. However, the lack of regression following irradiation of animals with melanoma and Lewis bladder carcinoma may also have been due to the low levels of energy per pulse available. Neoplastic changes attributable to laser irradiation were not observed in normal or tumor-bearing animals in which regressions permitted survival for protracted periods, although the free radicals are produced by laser irradiation in normal tissues. (BBB)

4677 VESICOURETERAL REFLUX AFTER RADIOTHERAPY OF THE URINARY BLADDER. Zingg, Ernst (Univ., Zurich). Z. Urol., 58: 817-23(Dec. 1965). (In German).

Compared with conventional x irradiation, supervoltage therapy produces only slight or moderate cystitis in 5 to 20% cases after treatment of the urinary bladder. The irradiation results are less favorable if a bacterial infection is present. Intracavitary ^{60}Co irradiation produces more severe injuries, such as epithelial damage, fibrosis, or contraction. A series of 32 patients with bladder papillomas, and carcinomas were given either 7000 to 9000 R of intracavitary ^{60}Co irradiation and/or 6000 R of betatron or telecobalt irradiation. After the intracavitary ^{60}Co irradiation the bladder wall became ulcerated, fibrosed, contracted, and infected. These symptoms were still evident after 3½ to 9 yr of follow-up studies. All of these patients had some degree of vesicoureteral reflux. In contrast, the patients treated by the betatron or telecobalt irradiation showed 22 cases of cystitis that cleared up within 6 months. In 4 of these patients infections appeared, and there was 1 case of vesicoureteral reflux. In follow-up studies of these patients for 4 yr 5 cases of cystitis, 6 cases of vesicoureteral reflux, 1 tumor recurrence, but in 17 there was no infection evident. (BBB)

4678 RADIOTHERAPEUTIC RESPONSE OF PRIMARY LUNG CARCINOMA ACCORDING TO CELL TYPE. Silbiger, Martin L.; Lott, Stewart (Johns Hopkins Univ., Baltimore). Bull. Johns Hopkins Hosp., 119: 283-7(Oct. 1966).

The effect of 250-KV and 2-MeV x rays on various types of lung tumor was studied, with reference to 105 cases. The frequency distribution of histologic types was as follows: squamous cell carcinoma 33 cases, large cell anaplastic carcinoma 41 cases, oat cell carcinoma 19 cases, and adenocarcinoma 12 cases. Tumor doses given with 250-KV and 2-MeV x rays were substantially the same, and no significant differences were found in the median and mean doses given in any of the main histologic types. The doses ranged from 2250 to 6240 R, with an average of ~4300 R given in 31 days. A comparison of survival data in both treated and untreated series revealed a distinct difference as to rapidity of spread of disease and survival time, between anaplastic lesions on the one hand and squamous cell and adenocarcinomas on the other. Not only did patients with undifferentiated or anaplastic carcinomas seem to develop distant metastases more quickly than those with squamous cell or adenocarcinoma, but also it appeared that patients with oat cell carcinoma have the shortest median survival time. Radiotherapy had a slight but favorable influence, particularly in the squamous cell and adenocarcinoma groups. When treated and untreated lesions of limited extent were compared, without reference to histology, a slight improvement was noted in the treated group in median survival time. (BBB)

4679 FLUORINATED PYRIMIDINES AS RADIO-SENSITIZERS IN THE TREATMENT OF CANCER OF THE STOMACH. Falkson, G. (Univ., Pretoria). S. Afr. J. Radiol. 3: No. 3, 14-16(Apr. 1965). (In Afrikaans).

One hundred-eighty six patients with metastases from stomach cancer were studied. It was concluded that combined 5-fluorouracil (5-FU) and telecobalt treatment are more effective than either treatment on its own. Normal tissues were more sensitive to irradiation after 5-FU, but the therapeutic ratio between normal and tumor tissue was increased, enabling the use of smaller doses of each form of treatment to achieve therapeutic results. (auth)

4680 EFFECTS ON IONIZING RADIATION ON PASTEURELLA INFECTION IN HENS. Feteanu, A.; Ungureanu, C.; Minciuna, V.; Corneci, I. Lucr. Inst. Cercet. Vet. Bioprep. "L. Pasteur," 2: No. 2, 361-70(1965)(Publ. 1965).

The investigation was performed on 214 Rhode Island and Leghorn hens, aged four to ten months, obtained from various active foci or foci that were going to be extinguished. A group of hens were parenterally infected by a Pasteurella avium strain, that was attenuated for this species. The x-ray biological dose was calculated relative to hen weight and experiment duration. The findings revealed the following; death rate in hens irradiated four days previous to infection with the attenuated Paris II strain was 100 per cent within 48 hours, death rate in hens to which a four day irradiation was delivered after infection was 65.3 per cent within 13 days. The hens that were naturally or experimentally carrying Pasteurella germs, irrespective of strain pathogeneity, showed no cholera symptoms during internal or external exposure. In the occurrence and evolution of the Newcastle disease within a population, an important part is played by individual body resistance, strain pathogeneity, and the number of Pasteurella carriers in that population. (Romanian Sci. Abstr.) (auth)

4681 CHANGES IN THE URETERS AND KIDNEY PELVIS IN CERVIX CARCINOMA AFTER IRRADIATION AND SURGERY. Galanopoulos C. (2nd Univ., Athens). Geburtsh. Frauenheilk., 26: 754-8(May 1966). (In German).

Follow-up studies were performed on 62 patients after surgery and/or irradiation for treatment of uterine carcinoma. Of these, 26 were irradiated by Ra, implanted twice over a 20 day interval, or by ^{60}Co, given in 25 separate doses, and were subjected to radical vaginal-abdominal-uterine extirpation. The other 36 patients were treated by irradiation only. Studies on the patients were begun initially six months after the irradiations, and continued for four months. In 18 patients there were bladder complications that included six bullous edemas, 10 mucosal telangiectases, eight submucosal hemorrhages, six inflammatory fibrinitis, and one severe hemorrhage. In 13 of the cases followed up for the period from six months to four yr after the end of treatment the ureteral pathology observed included seven cases of ureteral dilation and edema, 10 of hydroureter and hydronephrosis, 10 pyelonephritis, one pyonephrosis, one ureteral stone, and seven silent kidneys. (BBB)

4682 RADIOISOTOPES IN MEDICINE. 6. RADIOISOTOPES IN RADIOTHERAPY. Minty, C. C. J. (Peter MacCallum Clinic, Melbourne). Med. J. Aust., 1: 578-80(Mar. 18, 1967).

Use of ^{90}Sr for extracorporeal irradiation of the blood in leukemia, ^{131}I in treatment of thyroid cancer, and ^{32}P in therapy of polycythemia vera is described, along with radiation doses received and complications encountered. Patients suitable for treatment with radioiodine are those with carcinomas that cannot be completely removed surgically. The tumor must take up radioiodine in sufficient quantity and retain it for sufficient time to allow irradiation of tumor tissue. Up to three days after the dose of radioiodine, kidneys and bladder will contain urine with a high radioiodine content. The patient must be kept in the hospital, and urine collected for safe disposal. The stomach and salivary glands excrete radioiodine, that may make location of metastases difficult. It is necessary to give a dose of 80 to 100 mCi to ablate the thyroid. When satisfactory uptake is achieved, therapeutic doses of 100 to 150 mCi are given at intervals of six to eight weeks, until the uptake in the tumor falls below 1% of the administered dose. The treatment is continued for 18 months, or until the tumor is no longer concentrating iodine. When multiple bone metastates are present, this course is modified and the dose reduced, to avoid bone marrow depression. Immediate reaction to treatment may include nausea three to 24 hr after treatment, and again four to 10 days later, when the radioiodine is released from the tumor. Swelling and tenderness are often present over tumor deposits; the skin over tumor deposits becomes red; epilation occurs over scalp nodules; salivary glands may swell. The late reactions include dryness of mouth, permanent depression of thyroid function, amenorrhea. In polycythemia, the hyperplastic bone marrow takes up sufficient radiophosphorus to protect normal tissue from significant effects, and at the same time achieve a therapeutic result. Treatment with radiophosphorus carries a low-probability risk of leukemia, but this is outweighed by the reduction in serious complications such as thrombosis. The quantity of radiophosphorus involved is such that few precautions are necessary. It is not essential that the patient be admitted to the hospital, nor are there any special measures taken to deal with urine. (BBB)

4683 TREATMENT OF THE FINGER INJURY OF ATOMIC BOMB SURVIVORS. Takagishi, Naoto; Tamaru, Takuro; Ueyama, Kheigi; Yamada, Motohisa; Takeda, Morihiro (Hiroshima Atomic Bomb Hospital). Nagasaki Igakkai Zasshi, 40: 596-7(Aug. 1965). (In Japanese).

Two decades after the atomic bombing of Nagasaki and Hiroshima few patients with burns required plastic surgery. However, cases of bone diseases have increased. Several patients had hand injuries and their treatment is reported. Case one, a 60 yr old man was exposed at a distance of 1.3 Km from the hypocenter while indoors, suffering burns of the left hand and right elbow so that the left fourth and right fifth finger became inflexible. Examination at the hospital showed a fissure in the left fourth finger joint, splintered glass in the left hand, paralysis of nerves in the hand, and loss of sensation in the thumb, forefinger, and middle finger. The patient was operated on to remove foreign matter from the finger joint. The palm muscles were rearranged and sutured together. Four months after operation the paralysis and sensation were obviously improved, the holding strength increased from two to 16 Kg, and the flexibility of the fingers increased. The patient could even play the violin. Case two, a 47 yr old man, was exposed at a distance of 1.3 Km from the hypocenter, on a bridge, and lost conciousness for five min. The right hand was painful and would not function. Treatment with Predonin injections was successful in relieving symptoms. (BBB)

4684 THE AGE OF DISEASE OCCURRENCE AND FOLLOW-UP EXAMINATION IN DIABETIC ATOM BOMB SURVIVORS. Shimiju, Kiyoshi (Hiroshima Univ.). Nagasaki Igakkai Zasshi, 40: 639-43(Aug. 1965). (In Japanese).

The pancreas has been considered to have a high sensitivity to ionizing radiation. However, correlation between the incidence of diabetes and atomic bomb exposure has not yet been studied extensively. In this report, clinical observations on diabetes in 213 atomic bomb survivors were discussed. Among 94 males (44.1%) and 119 females (55.9%) the incidence of diabetes was distributed mostly in the 50 to 59 yr age group (39.3% in males and 45.4% in females), and the average age at occurrence was 54.6 yr. Among the atomic bomb survivors at a distance of ≤2.0 Km from the hypocenter and early entrants into the city within three days after explosion, the incidence rate was highest in the 55 to 59 yr age group. For those at distances further than 2.1 Km and the entrants into the city at nine to 20 days, the incidence rate was highest in the 50 to 54 yr age group. The incidence of complications of diabetes was 50.2%. These complications included hypertension, heart disease, tuberculosis, hepatic disease, kidney disease, and cancer. As compared with persons not exposed to the bombing, the incidence of complications in bombing survivors was lower. Subjective symptoms, including exhaustion, thirst, pain, itching, polyuria, and inflammations, were present in 3.8% of cases. In 40% of the cases, the fasting blood sugar value was lower than 139 mg%, a value of 140 to 169 mg% in 21.1%, 200 to 245 mg% in 14.6%, 170 to 199 mg% in 14%, and above 250 mg% in 9.4%. In each group the incidence rate was highest in 50 yr old subjects. (BBB)

4685 A CASE OF ACUTE LEUKEMIA. Kamada, Nanao; Nimi, Masanobu (Hiroshima Univ.). Nagasaki Igakkai Zasshi, 40: 620-2(Aug. 1965). (In Japanese).

A case of acute leukemia in an atomic bomb survivor was studied. The patient was 59-yr old male painter. He was exposed at the distance 0.7 Km from the hypocenter. His symptoms and physical condition when he first visited the hospital are described. The results of clinical pathological examinations showed positive urinary urobilinogen, albumin-globulin ratio 1.5, γ-globulin 20.1%, bilirubin 1.0 mg %, serum alkaline phosphatase seven units, total cholesterol 89 mg %, serum Na 140 mEq/l, K 4.7 mEq/l, Ca 3.8 mEq/l, Cl 108 mEq/l, inorganic P 3.1 mg/dl. There was severe anemia, a decreased blood platelet level, and a red cell sedimentation rate of 64 mm/hr. Chromosome analysis of bone marrow and peripheral blood cells showed, among 66 cells examined, 93% with 47 chromosomes and trisomy in group G and C. Treatments included blood transfusion and administration of prednisolone and mitomycin. Symptoms improved for five months; however, after episodes of dyspnea and heart failure the patient died. Pathologic examination showed the swelling liver and spleen, bone marrow hypoplasia, and generalized infection. The leukemic cells were of the plasmablast series. (BBB)

4686 OBSERVATIONS ON THE ACCIDENTAL EXPOSURE OF A FAMILY TO A ^{60}Co SOURCE. Martinez, G. R.; Cassab, H. G.; Ganem, G. G. Com. Nac. Energ. Nucl. (Mex.), (Publ.), No. 238, 1-60(Nov. 1966). (In Spanish).

The observations made on five members of a family accidentally exposed to radiation emitted by a ^{60}Co capsule of 5 Ci were reported. The family members consisted of a husband and wife, a boy of 10, a girl of 2½, and the man's mother. The wife was 24 weeks pregnant. The doses, exposure time, and manifestations of radiation sickness were calculated for each. Four members of the family died; only the man survived. The clinical process of the disease, the hematological studies, and the postmortem results were reported in detail for each. (J.S.R.)

4687 CONSIDERATIONS ON A CASE OF MALIGNANT MYOBLASTOMA OF THE LEFT CHEEK APPEARING AFTER IRRADIATION FOR BASALOMA. Duchini, L. (Univ., Florence). Arch. De Vecchi Anat. Patol. Med. Clin., 46: 323-42(Nov. 1965). (In Italian).

A case of possible radioinduced sarcoma in a 68-yr-old woman receiving radiotherapy for another tumor is reported. Because of a basal cell epithelioma near the internal angle of the left ear, the patient had received a total 4200R dose of soft x rays. Thirteen months later a 3600R dose was given for recurrence of the tumor. Radiodermatitis appeared in the irradiated area, and four yr after the initial treatment a malignant myoblastoma was diagnosed as appearing on the left cheek. Histologic studies clearly distinguished between the primary and secondary tumors. Because of the latent period, the total dose administered, and the formation of the tumor in muscle exhibiting chronic radiation injury, it is considered likely that the secondary tumor represented an example of radiocarcinogenesis. A review is presented of numerous similar cases reported in the literature. (BBB)

4688 ETIOLOGICAL FACTORS OF LEUKEMIA. Georgii, A. (Univ., Munich). Muenchen. Med. Wochenschr., 106: 325-9 (Feb. 21, 1964). (In German).

Studies and observations based on hospital patients indicate that several factors may be responsible for the incidence of leukemia that was observed. The types of leukemia produced seem to be independent of the factors that cause them. Increased incidence of leukemia was noted as the result of exposure to atomic explosions, prolonged or intensive clinical x irradiation of patients, and in children whose mothers were exposed to x irradiation during pregnancy. Even the least exposure of embryonal cells to x irradiation may perceptibly increase the frequency of leukemia incidence in the offspring. Animal experiments have repeatedly confirmed this observation. Compared to other specialities, previous studies indicate that radiologists may have a rate of leukemia incidence almost 10 times as great. However, the increased incidence has dropped somewhat, probably because of improved measures for protection from irradiation. (BBB)

4689 RELATION OF DISTANCE TO FORAGING INTENSITY OF HONEY BEES (APIS MELLIFERA) ON NATURAL FOOD SOURCES. **Lee, William R. (Univ. of New Hampshire, Durham). Ann. Entomol. Soc. Amer., 58: 94-100(Jan. 1965).**

The effect of ^{131}I and ^{32}P on the foraging characteristics of bees was studied, and a method for distinguishing between ^{131}I- and ^{32}P-labeled bees is described. The radioisotopes were provided near beehives as 1 to 1.5 mCi amounts in 2 quarts of sugar solution. For bees fed ^{131}I the ratio of scintillation count to G-M count was 16,828, because the scintillation detector was far more sensitive to γ radiation from ^{131}I than the G-M tube, and very little of weak β radiation from ^{131}I escaped from the bee and penetrated the G-M tube. In contrast, the ratio of scintillation count to G-M count for bees fed ^{32}P was only 0.637, because of the high efficiency of the G-M tube in detecting energetic β particles from ^{32}P; whereas, the scintillation detector was shielded from β particles and counted only Bremsstrahlung produced by the β particles. Therefore, it was possible to distinguish between bees fed ^{131}I and ^{32}P by the ratio of scintillation counts to G-M counts. A dose of 1 mCi of ^{32}P per colony produced a significant effect on the distribution of foragers; a dose of 1.5 mCi of ^{131}I also showed an effect; however, 2 apiaries in one experiment that were fed only 1 mCi of ^{131}I failed to show any effect of the ^{131}I on the distribution of foragers. The effect of radioactive isotopes on foraging was surprising in view of previous negative results; however, comparisons within a group of colonies among bees containing varying amounts of the radioisotope are more sensitive than comparisons among colonies of different genetic stock, such as made previously. The apparent high sensitivity of workers to radiation in comparison to most other insects studied is likely due to relatively rapid cells division in the ventriculus of the honey bees. (BBB)

4690 ALTERATIONS OF THE FUNCTION OF THE ADRENAL CORTEX FOLLOWING SUPRALETHAL TOTAL-BODY IRRADIATION. **Szebok, Zoltan; Petranyi, Gyozo; Baumgartner, Edit; Fachet, Jozsef (Univ. Medical School, Budapest). Orv. Hetil., 107: 1496-9(Aug. 7, 1966). (In Hungarian).**

Alterations of adrenal cortical function following supralethal whole-body irradiation were studied in rats. After a 1300-R dose of x irradiation, corticosterone level of the blood, in vitro corticosterone content, and aldosterone secretion of the adrenals were determined at various intervals. The hormonal secretion of the adrenal cortex exhibited a biphasic change that was more pronounced in the case of corticosterone. Following irradiation acute corticosterone hypersecretion developed; after termination between 48 and 72 hours postirradiation, increased secretion was again noted. The two phases were not as distinct in the case of aldosterone secretion. Histological examinations corroborated the alterations in steroid secretion. Disturbances of salt and fluid metabolism related to the changes of adrenal cortical function are discussed. (BBB)

4691 ULTRASTRUCTURAL CHANGES IN THE CEREBELLUM AFTER FOCAL DEUTERON IRRADIATION: CEREBELLAR IRRADIATION. **Samorajski, T.; Zeman, W.; Ordy, J. M. (Cleveland Psychiatric Inst., Ohio). J. Neuropathol. Exp. Neurol., 26: 40-59(Jan. 1967).**

The sequence of ultrastructural changes in neurons, blood vessels, and glial elements in the beam path after focal irradiation of the brain of mice with 20-MeV deuterons was examined in detail. The cerebellum were examined 5 min to 10 days after irradiation at 68,000 rad by microbeams delivered through 9.0 × 0.025 mm slit apertures at 8.02 krad/sec. Each mouse received 1 midsagittal and 4 parasagittal slit-beam exposures to the brain at intervals of 0.5 mm from the interhemispheric fissure. Histologic examinations revealed various cytoplasmic changes in granule cells as early as 1.5 to 2 hr after exposure. At longer postirradiation periods, sequential changes to granule cells included pyknosis, karyorrhexis, and ultimately cell destruction. At 2 hr, electron microscopic examinations revealed various changes in nuclear membranes and cytoplasm. More extensive displacement of nuclear membranes, condensation of nuclear material, swelling of the endoplasmic reticulum, and disintegration of some mitochondria became apparent 5 hr subsequent to the irradiation of the granule cells. By 20 to 36 hr, the microbeam lesions were characterized by tissue debris, degenerating axons, and swollen perivascular pericytes associated with edema, hemorrhage, and polymorphonuclear leukocyte infiltration of irradiated tissue. The findings suggested that some early neuronal and vascular changes after high-dose deuteron irradiation may occur independently. (BBB)

4692 RADIOLOGICAL PICTURES OF THE ASEPTIC OSTEONECROSIS OF THE FEMORAL HEAD IN THE ADULT. **Ghigo, Mario; Caporale, Antonio. Radiol. Med., 53: 456-71 (May 1967). (In Italian).**

After discussing the etiopathology and describing and exposing the radiographic picture of the aseptic osteonecrosis of the femoral head in the adult, 10 cases are presented and divided as follows: six cases due to vasculo ischemic factors that were not well defined; two cases connected with prolonged therapy of cortisone in patients affected by lupus erimatosus; and two cases due to radiotherapy of the little pelvis for uterine cancer. One case of secondary osteonecrosis with traumatic lesion followed by intervention and a case of dissecans osteonecrosis are also reported. The diagnosis that completely pertains to radiology may be uncertain during the first months of the disease while, during the period of status of the morbid form, the radiological picture was typical and did not present any particular difficulty of interpretation. (auth)

4693 EARLY CHANGES IN ULTRASTRUCTURE OF GLIAL CELLS AND MYELINIZATION IN RAT BRAIN AFTER X IRRADIATION. **Franke, H. D.; Lierse, W. (Univ., Hamburg). Fortschr. Geb. Roentgenstr. Nuklearmed., 107: 415-20(Sept. 1967). (In German).**

The effect of x-radiation (200 kV) on the capillaries and glia cells in the brains of 12 male and female rats was examined in the cerebrum and cerebellum 24 hours after irradiation (100, 500, 750, and 1000 R). A 100 R dose led to increased pinocytosis and increase in ergastoplasm in the capillary endothelium; 500, 750 and 1,000 R doses led to hydrops of the precapillary astroglia. After 1,000 R the extracellular space of the white matter was oedematous. This resulted in changes in the nerve sheath leading to separation of the lamellae. Primary damage (750 to 1,000 R) seemed to consist of thickening of the cytoplasm of the glia cells that also led to separation and destruction of the nerve sheath. (auth)

4694 VARIATIONS IN THE BLOOD ELECTROLYTES IN SOME TUMORS BEFORE AND AFTER RADIOTHERAPY. **Cappelli, I. (Istituto Regina Elena per lo Studio e la Cura dei Tumori, Rome). Riv. Radiol. Milan, 5: 165-73(1965). (In Italian).**

The behavior of the blood ionogram was studied in patients affected by different neoplasms, before and after radiation therapy. The initially observed ionic disturbances consisted in a fall of the serum K and in increase of the acid residue. Then, at the end of the radiation cycle, the ionogram showed that the K tended to increase, while the Ca and the total proteins showed a decrease in their blood rate. The acid residue remained augmented in general. (tr-auth)

4695 THE SATURATION EFFECT IN RETINA MEASURED BY MEANS OF He–Ne LASER. **Blabla, J.; John, J. (Inst. of Radio Engineering and Electronics, Prague). Amer. J. Ophthalmol., 62: 659-63(Oct. 1966).**

Laser effects were studied in the rabbit eye with a gas laser continuously operating at 6328 Å. Measurements suggested that retinal coagulation was possible with medium-power gas lasers. One min after exposure a fine edematous spot was observed on the retina. As the convergence angle of the laser beam was very small, the lesions had a smaller diameter than was obtained with a ruby laser. The lesions produced above threshold demonstrated more marked gray-yellow spots, most of which were craterlike. The laser energy absorption was partly manifested by an irreversible photobiologic effect (protein coagulation) and partially distributed in the adjacent tissue by heat conduction. For short exposure times, heat conduction into the adjacent tissue was very small, and almost all absorbed energy was converted into the coagulation effect. As the exposure time increased, the heat conduction increased too, and the threshold energy mounted. The heat equilibrium between the irradiated spot and the tissue was maintained from 500 msec and on the threshold energy was independent of the exposure time. For diameters of image sizes on the retina of less than 100 μ, a saturation effect took place between incident energy and exposure time. For image diameters of ~70 μ, a saturation threshold energy density of ~45 J/cm^2 was obtained. (BBB)

4696 THE EFFECT OF X IRRADIATION ON DEVELOPING DENTAL TISSUE. Borszewska, Hanna (Zaklad Stomatologii Zachowawczej, Poznan, Poland). Poznan. Tow. Przyj. Nauk, Wydz. Lek., Pr. Kom. Med. Dosw., 33: 5-31(1966). (In Polish).

Morphological changes and histochemical reactions of mucopolysaccharides in developing the mature dental tissues after x irradiation at a dose of 700 R were studied in embryo, newborn, and 3-month-old rats. In the 1st group, embryos at the 18th and 20th day of gestation were irradiated and decapitated 48 hr later. In the 2nd group, embryos at the 19th day were sacrificed on the 1st day after birth, 96 hr after irradiation. Rats in the 3rd and 4th groups were irradiated during the 2nd, 3rd, and 4th day after birth and examined after 24 and 72 hr as well as after 3 months. In the 5th group normal embryos, newborn, and 3-month-old rats were studied at the same time periods as the irradiated animals. Regressive changes in developing and mature dental tissue were found after irradiation. The histochemical reaction with Astral blue disappeared and the Periodic Acid-Schiff (PAS) reaction for polysaccharides remained in tissues at the early stages of tooth development following the action of x rays on the enamel organ; connective tissue of the papilla, membrana preformativa, and dentin; and enamel-producing cells. As a result, disorders of the amelogenesis, odontogenesis, and the mineralization process followed. Degenerative changes in the dental pulp and dedifferentiation of odontoblasts, which acquired a fibroblast-like appearance, were found in rats irradiated between the 2nd and 4th day after birth and investigated 24 to 72 hr later. The Astral blue and PAS reactions in these rats were absent. Late effects of irradiation were focal in character in the teeth of rats irradiated during the 2nd day of life and examined 3 months later. These changes were mostly in the root segments and periodontium and led to a gradual degeneration of the dental tissues. (BBB)

4697 RADIOSENSITIVITY OF THE MALE GENITAL GLAND OF THE WATER TURTLE EMYS LEPROSA. Combescot, C.; Groussin, P.; N'Gore-Kassi, F. (Faculte de Medecine et de Pharmacie, Tours, France). Compt. Rend. Soc. Biol., 151: 157-60(1967). (In French).

The testes of adult water turtles were exposed to x radiation doses between 1,500 and 3,000 R administered in a single dose or fractionated into five doses. The turtles were sacrificed at periods between 30 and 300 days after irradiation. The testes were removed and subjected to a histological study. The histological examination showed that the seminal activity was irreversibly repressed. However the interstitial gland was little affected. The turtles survive the destruction of the seminal epithelium. (J.S.R.)

4698 PERESADKA KROVETVORNYKH TKANEI PRI LUCHEVYKH PORAZHENIYAKH. (OBZOR LITERATURY I NEKOTORYE DANNYE EKSPERIMENTAL'NYKH ISSLEDOVANII). (Transplantation of Hematopoietic Tissues During Radiation Injuries. (A Review of Published Literature and Data on Experimental Studies)). Sukhanov, M. P. Leningrad, Izdatel'stvo Meditsina, 1967. 227p.

Data are given on the extraction of hematopoietic tissues from donors, the preservation of the tissues, the determination of the viability, times and methods of implantation of hematopoietic tissues, effects of radiation on the success of the transplantation, evaluation of the acceptance of the transplanted tissues, and medical effects of the transplants. Questions on the use of hormones and antibiotics in the transplantation are also considered. The results of experimental data and a wide selection of literature data from domestic and foreign sources are presented. (tr-auth)

Radiation Effects on Plants

Refer also to abstracts 4591, 4597, 4663, 4706, and 4715.

4699 (RLO-1783-13) THE ROLE OF NATURALLY OCCURRING QUINONES IN PHOTOSYNTHESIS. Yearly Progress Report, September 1, 1966–September 1, 1967. Bishop, Norman I. (Oregon State Univ., Corvallis). Contract AT(45-1)-1783. 9p. Dep. CFSTI.

Progress is reported in studies on the effects of uv radiation on photoreactions of green algae and chloroplasts and quinones isolated from Scenedesmus. Results indicated that the site of uv inhibition is prior to the site of plastoquisnone action in the electron transport chain. Vitamin K substances were isolated from the blue-green algae Anacystis nidulans, which possesses only plastoquinone A and two vitamin K type compounds. (C.H.)

4700 (TID-24146) FINAL REPORT [ON MORPHOGENETIC EFFECTS OF RADIATION]. Shapiro, Seymour (Oregon Univ., Eugene). [nd]. Contract AT(45-1)-1732. 18p. Dep. CFSTI.

Progress is reported on the following studies; effects of plant hormones on emergence of roots in Populus nigra; polarity of auxin transport; bioassay of poplar auxin; mode of action of triiodobenzoic acid as an anti-auxin, effects of x-ray dose on plants treated with indole acetic acid; effects of oxygen and nitrogen on radiation damage; effects of light and x rays on emergence of roots from the poplar stem; and radioinduced somatic mutations in roses, chrysanthemums, and geraniums. (H.L.W.)

4701 EFFECTS OF α RADIATIONS ON THE CELLS OF PLANTS. Biebl, Richard; Url, Walter (Univ., Vienna). Protoplasma, 57: 84-125(1963). (In German).

Leaves of the mosses Calypogeia neesiana, Bazzania trilobata, Metzgeria conjugata, Plagiochila asplenioides, Bryum capillare, Hookeria lucens, and Mnium punctatum, and of onion plants Allium cepa were irradiated with α particles from a ^{210}Po source. The source strengths used ranged from 6.25 mCi to 105 mCi, and irradiation times used ranged from 10 sec to 24 min. The irradiated plant cells were evaluated 24 hr after the irradiations. Compared on the basis of the product of the source strength and the irradiation time in sec, cell deaths susceptibility ranged from 1460 mCi-sec for Plagiochila asplenioides to 21,900 mCi-sec for Hookeria lucens. The lethal dose was relatively constant for each plant cell type. Radiosensitivity varied with the developmental stages. External epidermal cells of summer red onions showed increased radiosensitivity over the 24-hr study period. Radiosensitivity of the onion cells increased from outer to inner portions of the plants. Cell deaths that occurred within 24 hr were attributed in large part to irradiation injuries of the cytoplasm. Prolonged deaths were attributed primarily to radiosensitivity of the cell nuclei. In the dead onion cells, chondriosomes and leukoplasts were deformed and degraded with Kappa plasmolysis protoplast contraction. Onion cell death was widely scattered in pattern, but in the mosses death occurred in large masses. Increased plasma viscosity was marked in the moss cells after sublethal irradiation. In Hookeria lucens the α irradiation range was insufficient to affect the entire 40 to 50 μ dia of the cells and only the chloroplasts adjacent to the cell walls were altered after sublethal irradiation. Comparison of unilateral and bilateral irradiation studies indicated that lethality was independent of the region irradiated but directly related to the total dose administered. After weak, sublethal irradiation, Hookeria cells demonstrated regeneration of protonema when placed in water. References cited, 63. (BBB)

4702 STABLE AGAR BY GAMMA IRRADIATION. Doshi, Y. A.; Rao, P. S. (Central Salt and Marine Chemicals Research Inst., Bhavnagar, India). Nature (London), 216: 931-2(Dec. 2, 1967).

Dry agar slowly deteriorates during storage, probably because of some degree of inherent instability and also because of unidentified impurities. Some interesting studies are described on agar extracted from gamma-irradiated dry seaweed. The seaweed was ^{60}Co-irradiated to 0.9 to 6.4×10^4 R/g, and gel strengths of the extracted agar were determined immediately and after various storage periods. The results indicated that gel quality increased with dose up to a critical dose, which differs with species, and that instability is not observed on storage up to two months. An additional irradiation effect was enhancement of gelling power. It is suggested that the increased stability may be due to reduction of sulphate content by irradiation. The use of the γ-cell of a Van de Graaff generator is suggested. (UK)

4703 EFFECTS OF CHRONIC GAMMA RADIATION FROM RADIO-COBALT (^{60}Co) IN MUSTARD (BRASSICA JUNCEA, COSS). Das Gupta, P. (Bose Inst., Calcutta). Genet. Agr., 19: 283-304(Dec. 15, 1965).

Laha 46, a pure line variety of Brassica juncea, Coss. was exposed to chronic γ radiation, ^{60}Co throughout its cycle to induce mutations and other genetic variabilities. Evidence is presented to prove that higher dosages like 20, 13, 263 mR, 7,30, 426 mR, and 2,62, 903 mR, gave rise to plants short in height, early in flowering, with reduced branching, less stability in the chemical nature of oil and chlorophyll deficiency with variegated appearance. In the γ^3 generation all the chlorophyll mutants died at the seedling stage, demonstrating the presence of recessive lethal genes. Successive generations obtained from heterozygous green plants produced three green plants to every white one, suggesting a single pair of alleles. Genotypic variability was studied in a collection of fourteen selections in the γ^3 generation. Genetic coefficients of variation, heritability estimates and genetic advances were computed to show the effect of selection pool on characters like no. of branches, height, no. of fruits, weight of seeds, and time of 1st. flowering. Heritability values were noted to be very high in number of branches with very high values in genetic advance and expected gain in percent of mean. These results showed that progress had occurred within the selections. (auth)

4704 EFFECTS OF AUXIN ON ROOT GROWTH AND MODULE FORMATION OF X-IRRADIATED MEDICAGO SATIVA. Vanossi Este, S.; Caprotti, M. (Univ., Pavia, Italy). Genet. Agr., 19: 303-13(Dec. 15, 1965). (In Italian).

Auxin added to the culture medium of seedlings of Medicago sativa (Cremonese population), partly neutralized the damage caused by small dosages of irradiation on the growth of the roots and on nodule formation by Rhizobium melliloti. (auth)

4705 UPTAKE OF ^{90}Sr AND ^{134}Cs IN SCENEDESMUS ACUTUS MEYEN-GREEN ALGAE. Peterfi, S.; Pavel, T.; Nagh-Toth, F. Rev. Roum. Biol., Ser. Bot., 11: 327-31(1966). (In German).

Investigations were made on the uptake capacity of ^{90}Sr and ^{134}Cs in Scenedesmus acutus and their influence on plant development in culture medium synthetic solutions. The experiments revealed a massive accumulation of ^{90}Sr, emphasizing that S. acutus does not take up ^{134}Cs. Both elements have a manifest stimulating effect on plant development. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 4565, 4566, 4570, 4593, 4663, 4680, 4715, and 4724.

4706 (RLO-1952-2) MECHANISM OF PHOTOREACTIVATION OF PLANT VIRUSES. Progress Report. Chessin, Meyer (Montana State Univ., Missoula). Sept. 28, 1967. Contract AT(45-1)-1852. 8p. Dep. CFSTI.

Progress is reported on studies on the mechanism of photoreactivation of plant viruses. Data are included from studies on the effects of 6-furfurylaminopurine and actinomycin D on the synthesis of RNA in tobacco mosaic virus (TMV) and plant cells of the host; the effects of high and low temperatures during exposure to uv radiation on the photoreactivation of TMV and several other plant viruses; the effects of cytochrome C or TMV or TMV-RNA when Nicotiana glutinosa was used as the assay plant; and the relation of the metabolism of protein and RNA by Nicotiana glutinosa on photoreactivation of TMV. (C.H.)

4707 THE RELATIONSHIP BETWEEN CAROTENOID PIGMENTS AND RESISTANCE TO RADIATION IN NONPHOTOSYNTHETIC BACTERIA. Mathews, Micheline M. (Boston City Hospital); Krinsky, Norman I. Photochem. Photobiol., 4: 813-17(Sept. 1965).

A radiation-resistant Micrococcus species and a colorless mutant subjected to ^{60}Co γ radiation were found to have identical killing curves. Similar results were obtained with uv light. However, when exposed to visible light in the presence of the photosensitizer, toluidine blue, the pigmented wild-type was unaffected, whereas the colorless mutant was killed. Sarcina lutea and a colorless mutant were killed at similar rates following exposure to x rays and uv light, whereas previous studies demonstrated that the pigmented wild-type is protected against lethal photosensitizations by visible light. It is concluded that the effect of carotenoid pigments in radiation damage is limited to protecting cells against the lethal effects of visible light and is without effect at shorter wavelengths. (BBB)

4708 PHOTOSENSITIVITY OF SEMLIKI FOREST AND OTHER VIRUSES. Appleyard, G. (Australian National Univ., Canberra). J. Gen. Virol., 1: 143-52(Apr. 1967).

Semliki Forest virus was inactivated by exposure to daylight or artificial uv and visible light (3300 to 4700 Å). Maximum inactivation occurred at 3500 to 4000 Å. Daylight probably inactivated Semliki Forest virus by affecting its nucleic acid. Virus was also inactivated by uv light and by heat. As expected, uv light destroyed the infectivity of whole virus and of extractable RNA at similar rates, whereas heat affected the extractable RNA much less than the virus. The effects of heat and uv light on free RNA were similar to those on the virus-associated RNA. These results suggested that the inactivation of Semliki Forest virus was probably the result of sensitized photo-oxidation of the viral nucleic acid, the sensitizing agent being some substance derived from the cells or culture medium. Several compounds were considered as possible photosensitizers. The virus was photosensitized by adding riboflavin or vitamin A, and the effects of these two compounds were therefore studied in detail. The findings indicated that neither of these substances was the natural photosensitizer. Sindbis, Murray Valley encephalitis, influenza, and rabbitpox viruses also lost infectivity when exposed to light, but poliovirus was photoresistant. (BBB)

4709 PHOTOSENSITIVITY OF SP 8 AND SP 3 PHAGES OF BACILLUS SUBTILIS. Kalab, D. (National Enterprise, Ivanovice na Hane, Czech.). Acta Virol. (Prague), Engl. Ed., 10: 279(May 1966).

For assaying the kinetics of inactivation of infectivity of the phages by uv light, a germicidal lamp (Philips TUV), emitting at 2537 Å, and 0.01M phosphate buffered saline (PBS) at pH 7 as medium for irradiation, were used. Logarithmic survival curves were observed, and the doses of uv light required to inactivate the phage to a survival of e^{-1} (one hit) were measured; they were 299 and 75 erg/mm^2 for SP 8 and SP 3 phages, respectively. In other experiments, the kinetics of photodynamic inactivation of infectivity of SP 8 and SP 3 phages was studied in 0.01M PBS containing 0.001M $MgSO_4$ and $1:10^5$ methylene blue at pH 7. A tungsten lamp was used as a light source. Inactivation curves of both phages showed a small initial shoulder followed by a linear portion. The relative sensitivities to the photodynamic inactivation were compared from the slope of the inactivation curves in the exponential part. First-order rate constants for photodynamic inactivation of infectivity in the presence of methylene blue were calculated; k(min^{-1}) values were 0.57 and 1.15 for SP 8 and SP 3 phages respectively. Under the same experimental conditions, eosin had no detectable effect on the infectivity of the phages tested. Results on the relatively low rate of uv-induced photodimerization of 5-hydroxymethyluracil (HMU) in the frozen solution as compared with that of thymine, as well as the high resistance of the solutions of HMU against the photodynamic action of methylene blue, suggest a correlation between the lower photosensitivity of SP 8 phage and the fact that it contains HMU instead of thymine. (BBB)

4710 ACTION OF ULTRAVIOLET RADIATION ON INFLUENZA VIRUS. Oberdoerster, F.; Thielecke, K. H.; Leibold, I. (Humboldt-Univ., Berlin). Z. Ges. Hyg. Ihre Grenzgeb., 13: 267-70(Apr. 1967). (In German).

This report describes the effects of uv radiation on influenza virus that was cultivated in embryonated chicken eggs and stored at −70°C. The hemagglutination titer was determined immediately before the experiment. The initial suspensions were treated with uv light for varying periods, then recultivation of virus was attempted in the eggs. After an irradiation dose of 80 mw-sec/cm^2, recultivation of the virus failed. The curve of the uv dose effect upon the infectivity of the virus was S-shaped. The sensitivity of influenza virus to uv approximately corresponded to that of bacteria, as previously reported. The uv inactivation curve was similar for influenza and Bacillus pseudoanthracis, the 50% inactivation dose in both microorganisms being 16 mw-sec/cm^2. (BBB)

4711 EFFECT OF UHF RADIATION ON CONCENTRATION OF THE INTERMEDIATE PRODUCTS OF GLYCOLYSIS IN YEAST CELLS. Deyamidava, S. I.; Kulin, Ya. T. Vestsi Akad. Navuk BSSR, Ser. Biol. Navuk, No. 2, 84-6(1967). (In Belorussian).

The concentrations of intermediate products of glycolysis (glucose-6-phosphate, phosphotriose, fructose-6-phosphate, fructose-1, 6-diphosphate, and phosphopyroracemic acid) were determined in yeast exposed to UHF radiation. Radioinduced changes in enzyme activity and radiation effects of heating were utilized in making these determinations. It was found that the concentration of phosphotriose was increased by a factor of 21; changes in the concentration of the other intermediate products were less pronounced. These changes differ from those caused by conversion heating of yeast cells. The observed changes were related to the effects of the UHF field on the cell enzymes. The combined effects of heat and non-thermal UHF energy transformations in the cell protoplasm were explained. (tr-auth)

4712 LETHAL UNBALANCED GROWTH IN BACTERIA. Bazill, G. W. (Medical Research Council, Harwell, Eng.). Nature (London), 216: 346-9(Oct. 28, 1967).

The lethal effect of unbalanced growth following damage by ionizing radiation or thymidine starvation is attributed to loss of ability to synthesize an outer cell wall that is strong enough for its essential role in cell division. (auth)

4713 CHEMICAL STUDY OF THE RADIOSENSITISATION OF MICROCOCCUS SODONENSIS BY IODINE COMPOUNDS. Mullenger, L. (Royal Military Coll. of Science, Shrivenham, Eng.); Singh, B. B.; Ormerod, M. G.; Dean, C. J. Nature (London), 216: 372-4(Oct. 28, 1967).

It has been shown that iodoacetamide and KI enhance the radiation inactivation of radiation resistant bacteria; similar results have also been obtained with iodoacetic acid. It was also found that sensitisation of Micrococcus sodonensis with iodoacetamide occurred only when the bacteria and sensitiser were co-irradiated, indicating that sensitisation was not caused by blocking of intracellular sulfhydryl groups before irradiation, or by the production of a stable toxic product. It was also demonstrated that some short-lived transients of iodoacetamide were responsible for the sensitising effect, formed by reaction with the radiolytic products of water. The aim of the investigation described was to discover

whether the solvated electron or the hydroxyl radical is involved in producing the toxic short-lived transient, and to determine the nature of this transient in iodoacetamide and KI. This could be done by studying the effect of scavengers for the solvated electron and the hydroxyl radical on the sensitising ability. Results suggested that the iodine atom, produced by OH radical attack, was responsible for the observed sensitisation. (UK)

Radiosterilization and Radiopreservation

Refer also to abstract 6246.

4714 (COO-1183-23) GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34 TO 50 F. Report to the United States Atomic Energy Commission, September 27-28, 1967. (Continental Can Co., Inc., Chicago, Ill.). Contract AT(11-1)-1183. 7p. Dep. CFSTI.

Studies on toxin development in fresh marine products were conducted. Estimates of spoilage based on odor were determined by an untrained consumer panel. Spores of Clostridium botulinum were inoculated into cod and haddock prior to irradiation. The irradiated fish and unirradiated controls were incubated at 50°F and below. Results at 46°F and below were favorable. (H.L.W.)

4715 (UCD-34P73-20) THE RADIATION PHYSIOLOGY AND MICROBIOLOGY OF FRUIT DETERIORATION. Annual Report, January 1-December 31, 1967. Bradley, Muriel V.; Buckley, Patricia M.; Sommer, N. F. (California Univ., Davis. Dept. of Pomology). Sept. 10, 1967. Contract AT(11-1)-34. 100p. Dep. CFSTI.

Progress on the effects of irradiated substrates on mitosis and growth and the radiation biology of postharvest pathogens and their hosts is reported. The research completed to date includes the following areas of investigation; radiation-heat synergism for inactivation of market disease fungi of stone fruits; effects of chemical protection on repair of potentially lethal irradiation injury in Rhizopus stolonifer sporangiospores; the irradiation of fruits and vegetables; radiation-heat interaction in postharvest treatment of strawberry fruits; responses of germinating Rhizopus stolonifer sporangiospores to heating, chilling, γ irradiation, and anoxia; γ radiation and heat for therapy of fruits and vegetables for postharvest diseases; and nontoxicity of irradiated sucrose solutions above pH 4.6 to Vicia faba root tip chromosomes. Detailed accounts of these areas of investigation, and the results obtained, are presented. (E.R.B.)

4716 COST-BENEFIT STUDY OF SELECTED PRODUCTS IN THE ATOMIC ENERGY COMMISSION'S LOW-DOSE FOOD-IRRADIATION PROGRAM. McKinney, F. E. Isotop. Radiat. Technol., 4: 389-96(Summer 1967).

A detailed cost-benefit study by Daniel Yankelovich, Inc., has recommended that the USAEC give firm support to research on irradiation of New England finfish and Hawaiian papayas, marginal support to research on Hawaiian mangoes, and no further support to research on Dungeness crab, Alaskan king crab, and bananas. The analysis was based on 310 interviews with industry personnel and 627 interviews with consumers. Government research reports were studied, and an attempt was made to arrive at real numbers for projected costs and benefits. Benefits will be increased sales and reduced spoilage losses. The report is summarized and reviewed. (auth)

4717 DESIGN OF THE WORLD'S FIRST INDUSTRIAL-SCALE GRAIN-IRRADIATION FACILITY. Carden, Joan E. Isotop. Radiat. Technol., 4: 396-8(Summer 1967).

The design of the world's first industrial-scale (50 tons/hr) grain irradiator, completed Feb. 1, 1967, is described. (auth)

4718 ETHICON WORLDWIDE COMPLEX OF ^{60}Co STERILIZATION UNITS. Artandi, Charles (Ethicon, Inc., Somerville, N. J.). Isotop. Radiat. Technol., 4: 399-403(Summer 1967).

The six Ethicon ^{60}Co sterilization facilities, in five countries, are described and the significant differences among them pointed out. (auth)

4719 GAMMA-IRRADIATION FACILITY OF KYOTO UNIVERSITY INSTITUTE FOR CHEMICAL RESEARCH. Gerrard, Martha. Isotop. Radiat. Technol., 4: 426-8(Summer 1967).

The 2-kilocurie gamma-irradiation facility of the Kyoto University Institute for Chemical Research is described. An interesting feature of the design is the mechanism that transfers the ^{60}Co pencils that make up the source from the storage pool to the irradiation position one at a time. (auth)

4720 SPANISH NAYADE IRRADIATION FACILITY. Gerrard, Martha. Isotop. Radiat. Technol., 4: 428-9(Summer 1967).

The Spanish Náyade 7700-curie ^{60}Co irradiation facility is described. (auth)

4721 INVESTIGATION OF RADIATION-STERILIZED ATROPINE INJECTIONS. Pandula, Egon; Farkas, Sandor (Medical Univ. of Budapest). Acta Pharm. Hung., 37: 78-84(Mar. 1967). (In Hungarian).

The possibility of radiosterilization of atropine used for injections was investigated. Irradiation with 2.5 Mrad was found to result in a 39% decomposition of the 0.1% solution. The decomposition was followed spectrophotometrically. Decomposition increased with an increase in atropine concentration or in the radiation dose used. It was also influenced by the oxygen content of the air above the solution. Addition of potassium pyrosulfite to the solution resulted in a considerable decrease in the extent of decomposition. (JPRS)

4722 RADIATION PASTEURIZATION OF TROPICAL FISH: BOMBAY DUCK (HARPODON NEHEREUS). Sawant, P. L.; Mavinkurve, S. S.; Saroja, S.; Savagaon, K. A.; Kumta, U. S. (Bhabha Atomic Research Center, Bombay). Food Technol., 21: 126A-30A(Mar. 1967).

The fresh storage life of an eviscerated fish, Bombay duck (Harpodon nehereus), at 10 to 12°C was extended by radiation pasteurization for 14, 21, and 46 days by doses of 0.25, 0.5, and 1 Mrad, in contrast to the rapid deterioration of the unirradiated fish within 3 days. Analyses are presented of the storage properties of irradiated and unirradiated fish, based on the sensitivity of spoilage bacteria toward radiation and heat, the nature of structural proteins, and drip losses. The relations between bacterial content, organoleptic score, and chemical indices of spoilage are discussed in the light of radiation-induced changes in spoilage flora. High bacterial counts were not indicative of spoilage in irradiated fillets (in contrast to unirradiated samples), the retention in the organoleptic attributes being determined by the level of radiation dose. Total volatile basic nitrogen content was a better index of incipient spoilage than was bacterial content or tyrosine equivalent in the irradiated fillets. (BBB)

4723 BIOLOGICAL BASIS OF THE POSSIBILITY OF THE PRESERVATION OF BLOOD IN PLASTIC PACKING STERILIZED TOGETHER WITH SOLUTIONS BY GAMMA RADIATION. Stakhovskii, Ya. V.; Davgalev, S. I.; Garbunov, P. T.; Buglov, Ya. D. Vestsi Akad. Navuk BSSR, Ser. Biol. Navuk, No. 2, 87-94(1967). (In Belorussian).

The possibility of sterilizing plastic bags together with preserving solutions with γ radiation and their utilization for preservation of blood was examined. In bags with preservatives, microflora of different forms were introduced: aerobic bacteria, white staphylococci, intestinal bacilli, spore-forming bacilli in quantities from 1 to 1 million microbes in 1 ml. The irradiation dose varied from 50,000 up to 800,000 R. It was found that doses of 500,000 R gave absolute sterilizing effects in all cases. Such a dose does not alter significantly the bags and the preservatives. The preservatives remain non-toxic and non-pyrogenic, and the antibacterial properties of the antibody contained in the preservative are not altered. The bags with preservatives retained their sterility for a long time. In γ-sterilized bags containing preservatives, there was no clear indication of radiation and post-irradiation hydrolysis or formation of toxic substances. Blood transfusions, from these bags, do not show pathological reactions with respect to the respiratory, cardiovascular, or blood systems. (tr-auth)

4724 MICROBIAL SELECTION DUE TO IONIZING RADIATION. Corlett, Donald A. Jr. (California Packing Corp., San Francisco). Food Technol., 21: 70-4(May 1967).

It was shown that low-dose γ irradiation readily inactivated the aerobic, psychrophilic Pseudomonas that, when present, was the major cause of spoilage in refrigerated fresh foods. Unless the initial numbers were very high, Pseudomonas could be completely eliminated at 0.1 to 0.2 mR. Hence spoilage of food packed in air-permeable containers and exposed to a low dose of radiation usually resulted from the growth of psychrotropic Achromobacter, yeasts, and sometimes by a variety of gram-positive rods. Vacuum-packed, irradiated food appeared to spoil from growth of lactobacilli. Because of the alteration of the spoilage pattern by the selective effects of irradiation on the microbial flora, an unconventional spoilage pattern may develop during storage. Classical low temperature spoilage, caused by Pseudomonas, was characterized by putrid and

ammonia-like odors and was readily apparent when the bacterial count exceeded 10^6 cells/g. On the other hand, spoilage of meat and fish irradiated in the low dose range was usually barely noticeable, even when the microbial count reached 10^9 cells/g. Spoilage of this type was usually characterized by sour odors. (BBB)

4725 STERILIZATION OF ONION MAGGOTS BY IRRADIATION WITH ^{137}Cs. McClanahan, R. J. (Canada Dept. of Agriculture, Harrow, Ont.); Simmons, H. S. Can. Entomol., 98: 931-5(Sept. 1966).

A study was conducted to determine the optimum age for irradiation of the pupae of the onion maggot, Hylemyia antiquia, for a specific dose of γ radiation, and also the effect of sterile males and females on the reproductive potential of a normal population. Pupae of known age groups were irradiated for 30 min to give a total dose of 3.0 kR. Most pupae treated with 3.0 kR when they were 4 days old or less failed to complete their development. Older pupae were more resistant and survived as long as untreated insects. The pupal duration of 18.1 days for males and 18.6 days for females was not affected by irradiation. Emergence peaks were well defined, with over 90% of the adults from each age lot emerging within a 3-day period. There was no indication that irradiation selectively killed male or female pupae. Females that emerged from treated pupae and were caged with normal males failed to lay any eggs. Dissection of some of these females revealed very rudimentary ovaries. It was not known whether mating had occurred or not. The lack of ovarian development indicated a mechanism of mitotic inhibition rather than dominant lethality. Since onion maggot females do not mate before the ovaries have developed, it is unlikely that the sterile females mated with the normal males. The males that emerged from treated pupae mated with normal females and many eggs were laid. The high degree of sterility of the treated males was not dependent upon the time of pupal treatment, and the few eggs that did hatch were distributed throughout the oviposition period. The undesirable effects of irradiation for a sterile-male eradication program (pupal mortality, delayed sexual maturity, decreased mating activity, and decrease in longevity) may be avoided by treating the pupae 8 to 12 days after they are formed. Male sterility was high when pupae were treated at that age. The effect of sterile flies on a normal population was optimal when there was a ratio of 6 sterile : 1 normal flies. This ratio was sufficient to drastically reduce the fertility of the eggs. Only 1.7% hatched, compared with 92% from normal populations. The higher radiosensitivity of the females is an advantage when field releases are considered, since it eliminates the necessity of separating the sexes. (BBB)

4726 LEGAL PROBLEMS IN FOOD IRRADIATION. Foa, E.; Eisenberg, E. (Soreq Nuclear Research Center, Yavne, Israel). 9p. (CONF-660829-1). DTIE.

From 4th National Meeting on Health Physics Problems, Yavne, Israel.

Advantages of introducing new techniques for food irradiation are pointed out. Legal problems concerning the use of irradiated food were studied by committees set up in various countries. Points taken into consideration for wholesomeness control were: chemical changes; changes in food value; presence of toxic materials; presence of carcinogenic materials; possibility of genetic changes and mutations; elimination of deleterious bacteria; and absence of residual radioactivity in the food. International aspects of legal problems are discussed. (H.L.W.)

4727 RADIOAKTIVNYE INDIKATORY V PISHCHEVOI I LEGKOI PROMYSHLENNOSTI. (Radioactive Tracers in the Food and Textile Industry). Pertsovskii, E. S.; Shubin, A. S. Moscow, Atomizdat, 1967. 220p.

A bibliography is presented on the use of radioactive tracers in the food and textile industries. Practical recommendations are given for the use of tracer techniques in the study of food processing (milk, meat, fish, milling, baking, sugar, butter-fat, beer, and perfume processing and production) and technological procedures for food preservation. Tracer techniques used in the study of textile finishing processes, fiber production, tanning, shoe manufacture, and glass and ceramic production are also reviewed. The use of this method for study of drying processes of different materials was discussed. (J.S.R.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 4315 and 4403.

4728 (BMI-X-455(Pt.1)) MECHANICAL AND PHYSICAL PROPERTIES OF FUELS AND CLADDING MATERIALS WITH POTENTIAL FOR USE IN BROOKHAVEN'S PULSED FAST REACTOR. Farkas, M. S. (ed.) (Battelle Memorial Inst., Columbus, Ohio). July 27, 1967. 225p. Dep. CFSTI.

A literature survey was conducted to provide mechanical and physical property data for unirradiated and irradiated fuels and cladding materials. The fuels include uranium alloys, plutonium alloys, and cermets. The cladding materials are iron-base alloys, nickel-base alloys, and molybdenum. These are of interest for potential use in Brookhaven's Pulsed Fast Reactor. (L.C.L.)

4729 (EUR-3495e) INTRODUCTION TO QUANTITATIVE AUTORADIOGRAPHY. Logi, P.; Vanossi, A. (Istituto di Ricerche Breda S.p.A., Milan (Italy)). Apr. 14, 1967. 31p. Dep.

Autoradiography, where used to obtain qualitative information on the distribution of a labeled element, proves to be a powerful research tool. Quantitative autoradiography however, presents difficulties both with respect to execution and interpretation of the results. Mathematical models developed for a quantitative approach to the problem lead to necessarily approximate theories. Furthermore such models are not capable, at least in most cases, of yielding exact quantitative relations concerning the autoradiographic process. Experimental quantitative techniques (grain or track counting) cannot be easily applied because of the great number of not precisely controllable factors. The employment of α-emitting radioisotopes could facilitate track-counting, but unfortunately those isotopes, most of which are heavy natural elements, are seldom used in research on element distribution. Of the methods described, the optical-density measurement of the developed autoradiograph seems preferable. The difficulties occurring with this technique can be reduced and the operation-time much lowered, by using standard radioactive sources in the form of thin small discs of photographic gelatine film containing a soluble salt of the radioisotope. A certain number of these standards are prepared for each β-emitting isotope, with various increasing concentrations. (auth)

4730 (LA-3766) VENTING EXPERIMENTS WITH A LIQUID PLUTONIUM ALLOY. Clifford, J. C. (Los Alamos Scientific Lab., N. Mex.). Aug. 15, 1967. Contract W-7405-eng-36. 9p. Dep. CFSTI.

To determine the feasibility of venting fission gases from a liquid Pu alloy fuel to Na, open capsules containing the fuel were immersed in flowing Na at 600 and 650°C. In some instances the fuel and Na were in contact; in others, a helium buffer was interposed. Container materials were Ta and a Ta-5W alloy with and without an internal coating of TaC. Pu losses from capsules without a TaC layer were excessive after test times as short as 1000 hr. The addition of the TaC layer reduced Pu losses to an estimated 10^{-4} to 10^{-6} of the original inventory per year. (auth)

4731 MATERIALS SELECTOR ISSUE. Materials Engineering, Vol. 66 No. 5, Mid-Oct. 1967. New York, Reinhold Publishing Corp., 1967. 590p. $15.00.

Chemical and physical properties of irons and steels, nonferrous metals, plastics and rubber, ceramics, glass, carbon, mica, fibers, felts, wood and paper, finishes and coatings, and composite materials are presented in tabular form. Processes, advantages, and limitations of metal parts and forms of materials are also discussed. (R.C.K.)

4732 KUPFER UND KUPFERLEGIERUNGEN IN DER TECHNIK. (Copper and Copper Alloys in Engineering). Dies, Kurt. Berlin, Springer-Verlag, 1967. 873p. $47.00; DM 188.-.

Topics covered include: metallurgy principles, production methods for copper and copper alloys, pure copper, engineering aspects of pure copper, and alloys of copper with groups 1, 2, 3, 4, 5, 6, 7, and 8 of the periodic system. (M.C.G.)

4733 BERYLLIUM METAL HANDBOOK. Hausner, H. H. (ed.). Yonkers, N. Y., General Astrometals Corp., 1967. 68p. $3.00.

A compilation of technical data on Be is presented. Information is reported, in tables, on the crystal structure, chemical composition, thermodynamic properties, nuclear characteristics, mechanical, electrical, and tensile properties, machining, joining, and compatibility of Be with other metals. (P.G.C.)

Corrosion and Erosion

Refer also to abstracts 4356 and 4825.

4734 (WAPD-TM-656) CORROSION AND HYDROGEN PICKUP OF ZIRCALOY IN CONCENTRATED LITHIUM HYDROXIDE SOLUTIONS. Kass, Stanley (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1967. Contract AT(11-1)-Gen-14. 52p. Dep. CFSTI.

An experimental technique for the controlled hydriding of Zircaloy-4 in concentrated lithium hydroxide solutions was developed. The procedure can be altered to yield uniform hydrogen distribution or to produce hydride rims. Zircaloy specimens must be insulated from all non-Zircaloy parts to prevent spurious results. (auth)

4735 THE EFFECT OF ANODIC FILMS ON THE GASEOUS OXIDATION OF TANTALUM. II. FILMS FORMED IN PHOSPHORIC ACID SOLUTIONS. Pawel, R. E. (Oak Ridge National Lab., Tenn.). J. Electrochem. Soc., 114: 1222-7(Dec. 1967).

The high-temperature oxidation characteristics of tantalum specimens anodized in phosphoric acid solutions were studied. The anodic oxide films containing phosphorus were found to be considerably more effective in limiting oxygen access to the metal and in postponing breakaway oxidation than phosphorus-free anodic films of the same thickness. Thickness-voltage calibrations were obtained for anodization in 0.9M and 14M H_3PO_4 electrolytes allowing quantitative measurements and comparisons of oxidation behavior to be made with that previously found for plain tantalum and for tantalum specimens anodized in dilute aqueous solutions. (auth)

4736 CORROSION IN NUCLEAR ENGINEERING. Collee, R. (Faculte des Sciences Appliquees, Liege). RUM, Rev. Universelle Mines, 110: 191-2(July 1967). (In French).

The temperatures of 500 to 600°C used in conduction of superheated steam cause many materials to corrode. The corrosion of Zr is sensitive to temperature as well as the presence of impurities and the superficial oxide film. Additives can improve resistance to corrosion of Zr; thus Ta and Nb improve this property but have high neutron cross-sections. A numer of materials have been shown to be useful at 400 to 500°C, but further work is needed to proceed to higher temperatures. The use of Be is limited by its metallurgical properties, but alloys may circumvent these problems. Addition of Ca or Mg provides satisfactory behavior even in moist CO_2 at about 700°C. Treatment of irradiated fuel raises problems requiring compromise between resistance to corrosion, aptitude to the conditions of the problem, welding characteristics, and heredity of metallurgical working. Pyrometallurgical corrosion in liquid metals, particularly of crucibles in extraction at 1200 to 1300°C, is a great problem; the use of TaB and Ta_2B has interesting features. (BBB)

4737 STUDY OF ERBIUM THIN FILM OXIDATION IN THE ELECTRON MICROSCOPE. Murr, L. E. (Pennsylvania State Univ., University Park). Phys. Status Solidi, 24: 135-48(Nov. 1, 1967).

ErO single crystals are formed during erbium evaporation onto NaCl in ultrahigh vacuum (10^{-8} Torr) and a unique twinning phenomenon in these fcc. NaCl-type crystals (a = 5.12 Å) is observed by electron microscopy. The oxidation of thin erbium foils (650 Å thickness) directly within the electron microscope by double condenser beam heating of selected areas and the sequential recrystallization and growth of the completely oxidized erbium (Er_2O_3) are investigated. It is shown that the Er_2O_3 films have a bcc structural characteristic with the unit cell defined by a vacancy defect CaF_2 structure composition possessing the T^5 ($I2_13$) space group for a = 10.55 Å. Er oxidation in the electron microscope at a background pressure of roughly 10^{-4} Torr appeared to be logarithmic, and presumably lattice diffusion controlled. (auth)

4738 DESIGN AND OPERATION OF TURBINE NOZZLE AND BLADE SCREENING TESTS IN POTASSIUM VAPOR. Cunningham, C. W.; Fleischer, B.; Fuller, L. C.; Huntley, W. R.; Jansen, D. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 428-9(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4739 THE OUT-OF-PILE COMPATIBILITY OF AUSTENITIC STAINLESS STEEL WITH MIXED-OXIDE FUEL. Lauritzen, T.; Comprelli, F. A. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 10: 459-60(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4740 CORROSION AND HYDRIDING OF ZIRCALOY-4 UNDER HEAT-TRANSFER CONDITIONS. Aqua, E. N.; Allio, R. J.; Thomas, K. C. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 466-7 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4741 EFFECT OF HYDROGEN ON MECHANICAL PROPERTIES OF ZIRCALOY-4. Johnson, C. R.; Lowe, A. L. Jr. (Babcock and Wilcox Co., Lynchburg, Va.). Trans. Amer. Nucl. Soc., 10: 465-6 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4742 HYDRIDE MORPHOLOGY IN ZIRCALOY TUBING. Schreiber, R. E.; Aqua, E. N. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 464-5 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4743 HYDRIDE ORIENTATION IN ZIRCALOY TUBING. Rittenhouse, P. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 464 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4744 TUBE WASTAGE IN SODIUM-WATER REACTION TESTS. Chamberlain, H. V.; Kovac, L. R.; Reicks, G. H.; Kovacic, E. C. (Atomic Power Development Associates, Inc., Detroit). Trans. Amer. Nucl. Soc., 10: 691-2 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4745 CORROSION BY MERCURY AND ITS INHIBITION IN ONCE-THROUGH 2 1/4 Cr–1 Mo STEEL BOILERS. Fleitman, A. H.; Romano, A. J.; Klamut, C. J. (Brookhaven National Lab., Upton, N. Y.). Nucl. Appl., 3: 737-44 (Dec. 1967).

Boiling mercury corrosion has been studied in natural-circulation once-through $2\frac{1}{4}$ Cr–1Mo steel loops operating at 315 to 703°C and 300 psi for 5000 hr at a flow rate of ≈11.5 kg/hr. The corrosion inhibition resulting from the presence of solid titanium or zirconium at the boiler inlet was determined by comparison with an uninhibited loop operating under similar conditions. No boiler corrosion was found in the inhibited loops, but the uninhibited loop had 20 to 25-μ thickness boiler corrosion. (auth)

4746 CARBURIZATION OF TYPE 304 STAINLESS STEEL IN LIQUID SODIUM. Holcomb, W. F. (Argonne National Lab., Idaho Falls, Idaho). Nucl. Eng. Design, 6: 264-72 (1967).

Microhardness scans across test specimens were used as a suitable metallurgical technique for determining quantitatively the carburization potential of molten sodium in contact with type 304 stainless steel. The advantage of using hardness data in this manner is that it could be used as a method of analysis of carburization specimens when chemical analyses are not feasible. Results indicated that microhardness values at 565, 605, and 650°C could be fitted to curves correlating the hardness to carbon content of liquid sodium. It was found that carbonaceous compounds intentionally mixed in liquid sodium gave a carbon source which produced carburization in the stainless steel test specimens. The capsule methods used for providing and controlling a molten sodium environment for the stainless steel test specimens indicated a need for further study in the use of various capsule-liner materials which are inert to carburization. (auth)

4747 INFLUENCE OF AN ALLOY ADDITION OF YTTRIUM ON THE OXIDATION BEHAVIOUR OF AN AUSTENITIC AND A FERRITIC STAINLESS STEEL IN CARBON DIOXIDE. Antill, J. E.; Peakall, K. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Iron Steel Inst. (London), 205: 1136-42 (Nov. 1967).

The influence of an alloy addition of about 0.5% Y on the oxidation behavior in carbon dioxide of a 20% Cr–25% Ni–Nb austenitic steel and a 15% Cr–4% Al ferritic steel was studied within the temperature range 800–1200°C. Assessments were made of the overall attack, the adherence of the oxide, internal oxidation, and the influence of internal oxidation on tensile properties. The effects of yttrium were similar in both steels. The element increased the general oxidation resistance and led to intergranular oxidation at temperatures ≥900°C, while the most significant effect at 800°C was a reduction in the overall attack of the austenitic steel. The effects were, in general, independent of the exact yttrium concentration. The intergranular oxide reduced the cohesion of grains in tensile tests on the austenitic steel at room temperature, 400°, and 800°C, and on the ferritic steel at the two lower temperatures, but not at 800°C. The yttrium is believed to exert its beneficial influence on the overall attack by several mechanisms. (auth) (UK)

4748 CORROSION OF LIGHT METALS. Godard, Hugh P.; Jepson, W. B ; Bothwell, M. R.; Kane, Robert L. The Corrosion Monograph Series. New York, John Wiley and Sons, Inc., 1967. 369p. $13.95.

The corrosion behavior of aluminum, beryllium, magnesium, and titanium and their alloys is described. The various types of corrosion that may occur in such environments as water, seawater, atmosphere, and soil are discussed. Information is also included on the behavior of welds, corrosion in transportation and storage, and cleaning of surfaces. (R.C.K.)

Preparation and Fabrication

Refer also to abstracts 4080 and 4537.

4749 (BM-RI-6984) PURIFICATION OF TUNGSTEN HEXACHLORIDE. Skirvin, Frederic A.; Campbell, T. T.; Block, F. E. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Dec. 1966. 17p. Bureau of Mines Free.

Purification techniques were investigated for removing low-level metallic impurities from tungsten hexachloride. These techniques included distillation, fused-salt scrubbing, zone refining, and adsorption. Fractional distillation of tungsten hexachloride was found to be an effective purification method. The impurity levels of molybdenum, iron, nickel, copper, magnesium, and manganese were reduced to provide a tungsten halide sample which contained a total of less than 10 ppM detectable metallic impurities. Purification by fused-salt scrubbing of tungsten hexachloride in a lithium chloride-potassium chloride eutectic produced a hexachloride product which was of approximately the same quality as that obtained by distillation. Zone refining and adsorption did not appear to be as effective as distillation or fused-salt scrubbing. (auth)

4750 (NP-17108) BERYLLIUM. DMIC Review of Recent Developments. Hanes, H. D.; Zurey, F. T. (Battelle Memorial Inst., Columbus, Ohio. Defense Metals Information Center). June 2, 1967. 5p.

A review of recent developments (Jan. 1966 to Jan. 1967) in the metallurgy of Be is presented. Data are given on machinability, joining, physical metallurgy, recommended machining processes including tool geometry, and corrosion protection. Significant data on Be–Al alloys and Be–Cu alloys are tabulated as are physical properties of brazing alloys. Ten references. (P.G.C.)

4751 (NP-17109) REFRACTORY METALS (Cb, Ta, Mo, W). DMIC Review of Recent Developments. Van Orsdel, J.; Houck, J. A.; Barth, V. D. (Battelle Memorial Inst., Columbus, Ohio. Defense Metals Information Center). May 12, 1967. 6p. DMIC.

Recent developments in the metallurgy and fabrication of Mo, Nb, Ta, W and alloys are reviewed. Mechanical and tensile properties are discussed as are the effects of H_2. Techniques of rolling, extruding, diffusion bonding, and welding are summarized. Twenty-nine references. (P.G.C.)

4752 CLEANING A (0001) BERYLLIUM SURFACE. Adams, Richard O. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Mater. Res. Bull., 2: 649-52 (July 1967).

The clean (0001) Be surfaces produced in these experiments were examined by the low-energy electron diffraction, using apparatus of the postacceleration display type. The crystal was degreased and placed in an ultrahigh vacuum diffraction chamber. After reaching a base pressure of 2×10^{-10} torr, the crystal was alternately heated in O_2, vacuum, H_2, and vacuum. It was then bombarded with Ar^+ ions which physically removed surface layers and Be itself, thus exposing a clean surface. Following this, the crystal was heated to 1150°C for 10 min during which there was a significant evaporation of Be. Since the crystal was cut from triple-pass zone-refined Be stock, it is reasonably certain that this treatment produces a clean surface. The diffraction pattern observed following the initial surface cleaning is shown. It is of a form which would be expected from a (0001) plane of Be and is typical of diffraction patterns obtained on clean surfaces. At a given electron-beam energy, the spots of the same order are of equal intensity, well-defined, and sharp, and the background intensity is low. Once clean surface conditions were established, the crystal was purposely contaminated by handling in air, and experiments were conducted to determine whether there is a less tedious cleaning process than the process described. Heating the crystal to less than 800°C produced no diffraction pattern, i.e., no cleaning. After 1 hr at 800°C the pressure stabilized at 4×10^{-9} torr following an initial and large increase, and a faint diffusion pattern emerged. Continued heating at 800°C up to 10 hr produced no change in this diffuse pattern. It was found that heating at

1000°C for 5 min was sufficient to clean the surface. Alternatively, a clean surface could be readily produced by Ar ion spluttering. When the crystal surface was sputtered with ions, the surface structure was destroyed and this destroyed the diffraction pattern. Annealing for 30 min at 750°C restored the surface structure and desorbed any Ar attached to the surface. Sputtering at 1000 V for 30 min cleaned the surface as efficiently as the 1000°C heating procedure. (BBB)

4753 FABRICATION OF V–Ti–Cr ALLOY FUEL CLADDING FOR LMFBR APPLICATIONS. Mayfield, R. M.; Karasek, F. J. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 475(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4754 PREPARATION OF URANIUM BY MEANS OF REDUCTION OF UO_3 BY CALCIUM VAPOR. Oki, Takeo; Tanikawa, Jun. Nippon Kinzoku Gakkai, 31: 1048-52(1967). (In Japanese).

Experiments on the reduction of UO_3 by calcium vapor and melting of the reduced uranium powder have been performed to determine the optimum condition for preparing a uranium metal powder with good fusibility and high purity. Further experiments for preparing a small uranium metal ingot from the produced uranium powder have been done. It was found that optimum conditions for preparing coarse uranium powder include a reaction temperature of 1100°C; Ca/UO_3 mol-ratio of 9; and reaction time of 2 to 3 hr (in case of this experimental scale). Yield percentage of coarse uranium powder (gray-white) is more than 90% under these conditions. The coarse uranium powder (gray-white) has better fusibility than the fine one (black or brown-black). Favorable conditions for making small uranium ingots include temperatures >1200°C; Ar atmosphere at 1 atm; and placement of metallic calcium outside of the crucible in the vessel. Purity of uranium ingots obtained under these conditions is more than 99.9%. Typical impurities are: Al, 3.2 ppM; Cd, 0.3 ppM; Co, 0.8 ppM; Cr, 7 ppM; Fe, 37 ppM; Mg, 14.5 ppM; Mn, 3.4 ppM; Ni, 54 ppM; Si, 43 ppM; Cu, 7 ppM; P, 44 ppM; Pb, 0.4 ppM. (auth)

4755 STRESS AND STRAIN CONSIDERATIONS FOR COMPOSITE ROD DRAWING. Flinn, J. E.; Rechtien, J. J. (Argonne National Lab., Ill.). Nucl. Eng. Design, 6: 217-22(1967).

Composite rod drawing was examined from both an experimental and phenomenological approach. Tubes of 304 stainless steel with cores of copper, aluminum, or 304 stainless steel were drawn to various reductions at constant die angle and coefficient of friction at the die-tube interface. When frictional effects at the core-tube interface are neglected (an assumption which was experimentally justified) the analysis showed that the draw stress should follow the standard rod equation with a composite yield criterion. The draw stress data agreed well with this theory with the exception of the case of pure sinking. Dimensional measurements of wall thickness were made which demonstrated that extrusion of the deformable cores takes place. (auth)

4756 THE RECRYSTALLIZATION AND WORK-HARDENING CHARACTERISTICS OF YTTRIUM AND TWELVE LANTHANIDES. Ross, I. N. (Johnson, Matthey and Co., Ltd., Wembley, Eng.). J. Inst. Metals, 95: 337-42(Nov. 1967).

The work-hardening and recrystallization characteristics were found to be markedly influenced by small amounts of impurities, notably copper, which forms low melting-point grain boundary phases with the lanthanides. Except for samarium and lutetium, it is possible to fabricate all the rare earth metals by cold-working techniques, thus avoiding excessive oxidation. Intermediate anneals are in vacuum. (UK)

4757 STRESS OCCURRING DURING INVERSE AND DIRECT EXTRUSION. Bagarello, Benedetto (Univ., Palermo, Italy). Ing. Nucl., 7: No. 3-4-5-6, 7-14(May-Dec. 1966). (In Italian).

The forces occurring in two cases of inverse and direct extrusion in the presence of friction resistance during displacement of the piston were determined on the basis of a preceding study on inverse extrusion conducted under Stassi classification conditions. Deformation of the dead zone was taken into consideration. This deformation begins at the instant at which the bottom of the piston reaches the base of the dead zone. The results obtained are compared with other experimental results. (tr-auth)

4758 PURIFICATION OF BERYLLIUM BY ZONE REFINING AND BY CRYSTAL PULLING FROM THE MELT. Grinyuk, V. N.; Papirov, I. I.; Tikhinskii, G. F.; D'yakov, I. G. Izv. Akad. Nauk SSSR, Metal., No. 4, 77-84(July-Aug. 1967). (In Russian).

Specimens of beryllium containing impurities in amounts varying from 0.003% for lead to 0.1% for iron were purified by zone refining or by pulling the crystals from the melt, in order to compare the effectiveness of these methods and to determine the behavior of individual impurities during purification. In zone refining, three passes lowered the iron, copper, chromium, magnesium, and aluminum contents but the specimens remained polycrystalline even after six passes. When zone refining was combined with dc or ac current application to the specimens, they solidified into single crystals after one or two passes. The current application also increased the effectiveness of zone refining and produced a deeper purification than that achieved without the application of current. Refining by the crystal pulling method in vacuum or in an inert-gas atmosphere produced specimens consisting of several large crystals with a purity comparable to that achieved by zone refining with one or two passes. It is believed, however, that improvements in the crystal pulling method could improve its effectiveness. In zone refining, yttrium and iron were found to have no negative effect on the elimination of other impurities. However, yttrium had a modifying effect on the structure of beryllium and prevented the formation of single crystals. Molybdenum had no such effect. Beryllium-molybdenum alloy single crystals containing 0.01% molybdenum were successfully grown. Elimination of carbon by zone refining was found to have a complex mechanism since carbon was eliminated not only by the zonal effect but also by the migration to the surface of the specimen. The latter phenomenon was especially marked in zone refining combined with ac current application to the specimen. (ATD)

4759 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUELS. (to Brown Boveri/Krupp Reaktorbau, GmbH). British Patent 1,089,102. Nov. 1, 1967. Priority date May 5, 1965, Germany.

A method is described for marking fuel or fuel elements for nuclear reactors to differentiate between normal fuel charges and test fuel elements. The method consists of adding to the fuel a substance to alter its neutron physics properties; adding a substance to the fuel element to alter its neutron physics properties; adding a substance such as Be which emits neutrons when exposed to gamma sources; or by adding a substance such as B which absorbs neutrons. (F.S.)

4760 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENT END CLOSURE. Lloyd, Henry (to United Kingdom Atomic Energy Authority). British Patent 1,093,259. Nov. 29, 1967. Filed Oct. 14, 1965.

A method of closing a tubular fuel element is described which consists of forming a reduced diameter neck portion on the end of the can and crimping the neck portion to close the end. A loose-fitting shaped end plug is inserted in the element before crimping and is sealed by an autogenous edge weld. A braze material is included with the end plug. The end assembly is heated after the braze material melts and the joint is sealed by capillary action. (F.S.)

4761 IMPROVEMENTS IN OR RELATING TO SINTERING PROCESSES. Butcher, John William; Samuel, Robert Lionel (to United Kingdom Atomic Energy Authority). British Patent 1,090,263. Nov. 8, 1967. Filed Apr. 17, 1964.

A compaction process in which particles of metallic powders are sintered at elevated temperature to form a solid body of high density, is described. Particles with an inert solid film forming a barrier to the formation of metal–metal bonds are hot pressed. The surface film remains solid but is penetrated by atoms of the underlying metal. Lower sintering temperatures are used which inhibits grain growth during sintering. (F.S.)

Properties Evaluations

Refer also to abstracts 5417, 5418, and 6176.

4762 (AD-648244) METASTABLE BETA SHEET ALLOY Ti-8Mo-8V-2Fe-3Al. PART I. Final Technical Report. Hunter, D. B. (Titanium Metals Corp. of America, New York). Oct. 1966. Contract DA-30-069-ORD-3743. 101p. (WAL-TR-405/2-14(Pt.1)). CFSTI.

A 500-lb. ingot of metastable beta alloy Ti-8Mo-8V-2Fe-3Al was melted and mill processed to plate and sheet for evaluation. No processing problems were encountered. Plate samples were evaluated in 2 in. and ½ in. sections at room temperature and 600°F. Smooth and notched tensile properties and K sub ic values were obtained. Samples taken from both sections of plate, solution treated, and aged for 16 hrs. at 900°F, had room temperature yield strengths of 190 to 200Kpsi; K sub ic values were 45 to 48Kpsi-square root of (in). Sheets of 0.040 and 0.060 in. gage were evaluated by determining 50 and 100% recrystallization parameters, using mill annealed sheet and hot rolled sheet given 25 and 50%

cold reduction. Aging response of these materials was then determined at 800 to 200°F and tensile properties evaluated after selected treatments. From this, 8 conditions of heat treatment were selected for further evaluation by sub-zero and 600°F smooth and notched tensile, bend, notched fatigue, K sub ic tests, measurement of creep stability; stress corrosion resistance, oxidation characteristics; and study of welding behavior. Ti-8Mo-8V-2Fe-3Al possessed good notch tensile strength at –65 to 600°F; the notched fatigue limit, with a notch configuration of Kt = 3.5, was 30 to 35Kpsi, and the plane strain crack propagation resistance was 45 to 60Kpsi-square root of (in). Creep curves were obtained, employing loads of 90% of the yield strength at 600°F, for exposure times of 500 hrs. (auth)

4763 (AD-648245) SCREENING AND SELECTION OF CANDIDATE SHEET ALLOYS. PART II. Final Technical Report. Hunter, D. B. (Titanium Metals Corp. of America, New York). Dec. 1966. Contract DA-30-069-ORD-3743. 174p. (WAL-TR-405/2-15). CFSTI.

Three alloys were selected as being suitable for addition of elements designed to bring about precipitation hardening: Ti-17V-10Cr-3Al, Ti-8Mo-8V-7.5Fe-3Al and Ti-15Mo-5Fe-3Al. Addition of 0.5-1%Si to Ti-17V-10Cr-3Al followed by water quenching from solution temperatures of around 2000°F and aging at 1150 to 1250°F, produced Vickers hardness increases of up to 100 points upon aging without visible microstructural change. Although precipitation hardening of a stable beta alloy was thus achieved, grain growth and embrittlement were encountered because of the high temperatures required to dissolve the silicide. Work was then redirected toward development of two other types of alloy: a moderate strength stable beta alloy, and a high strength metastable beta alloy hardenable by alpha precipitation. Two stable beta alloys, Ti-17V-10Mn-3Al and Ti-8Mo-8V-6Fe-3Al, and two metastable beta alloys, Ti-17V-4Fe-3Al and Ti-8Mo-8V-2Fe-3Al were evaluated. However, the stable beta alloys had brittle welds, and work on these was discontinued. They were replaced by 'stabilized' alloys, metastable alloys aged at 1100° to 1200°F to suppress the maximum aging response and reach a strength plateau. Four such alloys – Ti-8Mo-8V-5Co-3Al, Ti-17V-7.5Co-3Al, Ti-17V-2Fe-2Co-3Al and Ti-8Mo-8V-2Fe-3Al – were evaluated in this condition. Ti-8Mo-8V-2Fe-3Al proved to be best of the high strength metastable beta candidates. On a basis of smooth and notched tensile properties at room temperature and 600°F, creep stability and stress corrosion resistance, Ti-8Mo-8V-2Fe-3Al was selected for mill production. (auth)

4764 (AD-648451) INVESTIGATION OF FRACTURE IN CONNECTION WITH HOT DEFORMATION PROCESSING OF METALS. Final Report. Grant, Nicholas J.; Bridenbaugh, Peter; Greene, Barry; Kane, Robert (Massachusetts Inst. of Tech., Cambridge). Dec. 1966. Contract NOw-66-0104. 29p. CFSTI.

Topics included are: Hot plasticity at high strain rates and high temperatures of iron: deformation and fracture characteristics of Udimet 700 at high strain rates and high temperatures: deformation and fracture studies of molybdenum and its alloys at high strain rates and high temperatures. (auth)

4765 (ANL-7323) THERMOPHYSICAL PROPERTIES OF SODIUM. Golden, G. H.; Tokar, J. V. (Argonne National Lab., Ill.). Aug. 1967. Contract W-31-109-eng-38. 102p. Dep. CFSTI.

The literature about sodium properties through 1966 was reviewed as a basis for recommending current best values for such properties. Consideration was given to the liquid density, vapor pressure, thermodynamic and P – V – T properties, transport properties, electrical resistivity, and surface tension, as well as the thermal expansion coefficient, compressibility, and sonic velocity of the liquid. A FORTRAN subroutine was written to compute the enthalpy and entropy of sodium in a given state, and also the composition, mean molecular weight, specific volume, and compressibility factor of the corresponding vapor. Tabular results for the saturated liquid and vapor are presented in an appendix for the range 500 to 2500°F, in 10° increments. Also given are derived H – S and T – S diagrams. The transport properties are the viscosity and thermal conductivity of the saturated liquid and vapor; these are also presented in tabular form for the range 210 to 2500°F, in 10° increments. (121 references). (auth)

4766 (CEA-R-3287) MESURE DE LA CHALEUR SPECIFIQUE DES METAUX JUSQU'A LEUR TEMPERATURE DE FUSION. (Specific Heat Measurements on Metals Up to Their Melting Point). Affortit, Christian (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d' Etudes Nucleaires). July 1967. 63p. (In French). Dep. Thesis.

An apparatus was built to measure the specific heat of metal up to the melting point. The method is the pulse-heating method, where the specimen is heated very rapidly ($^1/_{10}$s) from room temperature to the melting point by a very intense dc current (1000 A). The simultaneous measurements of intensity, voltage and temperature in the specimen allows a calculation of the specific heat. Good results were obtained for niobium, tungsten, tantalum and uranium. Accuracy is from 3 to 5% and allows the measurement of the heat of formation of vacancies near the melting temperature. (auth)

4767 (GEMP-562) THE THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF TUNGSTEN-26 WEIGHT PERCENT RHENIUM. Feith, A. D. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Nov. 15, 1967. Contract AT(40-1)-2847. 21p. (CONF-671114-2; R-67-NMP-2). Dep. CFSTI.

Radial heat flow measurements of the thermal conductivity of W-26Re (wt %) have been made at 300 to 2200°C. These data identify a small positive temperature coefficient on conductivity with conductivity values ranging from 56.0 Wm^{-1} deg^{-1} at 300°C to about 69.0 Wm^{-1} deg^{-1} at 2200°C. Electrical resistivity measurements are also reported for both W-26Re and for unalloyed tungsten. This information was employed to calculate the electronic contribution to the thermal conductivity of the W-26Re alloy. At 300°C the electronic contribution was calculated to be about 65% of the thermal conductivity, whereas at 2200°C the conductivity is about 90% electronic. (auth)

4768 (IS-1688) HEMISPHERICAL SPECTRAL EMITTANCE OF THULIUM OXIDE. Stewart, R. K.; McMahon, W. R.; Wilder, D. R. (Ames Lab., Iowa). Oct. 1967. Contract W-7405-eng-82. 16p. Dep. CFSTI.

Hemispherical spectral emittance values, ranging between 0.7 and 0.8, are given for Tm_2O_3 at 2300 to 3000°K. In this interval emittance is linear with respect to temperature and is nearly horizontal. A carbon arc image furnace and a photocell detector were employed to obtain the data reported. (auth)

4769 (IS-T-205) SESSILE DROP TEST TO STUDY WETTING BY LIQUID METALS IN METALLIC SYSTEMS. Maze, Robert Craig (Ames Lab., Iowa). Nov. 1967. Contract W-7405-eng-82. 60p. Dep. CFSTI.

Thesis.

The wetting of 316 stainless steel by lead-bismuth eutectic was determined using a sessile drop test at 140 to 620°C and at 10^{-6} to 10^{-7} torr. An exact computation procedure has been developed to calculate surface tension and contact angle from a measured sessile drop shape when the contact angle is less than ninety degrees. The procedure uses a non-linear regression technique combined with the differential equations used to describe the sessile drop. Initial estimates of the drop shape parameter β and the radius of curvature at the drop apex (b) must be made to start the computation. Estimated values of β can be made using an eighth-order polynomial for β up to 100. The average absolute deviation in β over this range is 0.003. A computer program to perform the calculations has been written and is explained. Surface tension for lead-bismuth eutectic was found to decrease linearly from 418 dynes/cm at 140°C to 400 dynes/cm at 600°C with a negative slope of 0.04 dynes/cm/ degree. Studies carried out at constant temperature show that drop surface tension increases, contact angle decreases, and spreading coefficient increases with time when the temperature is held constant at temperatures above 400°C. Vaporization of the drop material and extraction of elements from the 316 stainless steel by the drop combine to cause this. Chemical analysis of the drop shows that chromium, nickel, iron, and manganese concentrations within the drop all increase with temperature. It was found that microprobe analysis of the interface of a frozen drop-to-316 stainless steel cross section would show the extent to which the drop penetrates the 316 and in addition would give an estimate of the concentration profile of a given element across the drop-stainless steel interface. Results of this study were obtained using relatively inaccurate drop coordinate measuring equipment. (J.C.W.)

4770 (NP-17123) COPPER-ZIRCONIUM ALLOYS (A LITERATURE SURVEY). Information Circular IC 186. Dion, J. L.; Thomson, R. (Department of Energy, Mines and Resources, Ottawa (Ontario). Mines Branch). Nov. 1966. 24p. Dep. CAN $0.75.

A review of work on high-conductivity Cu – Zr alloys is presented, covering such topics as the phase diagram, melting procedures, fabrication, heat treatment, properties and applications. Comparative reference is made to other high-conductivity alloys. The further development of Cu – Zr alloys includes the addition of third elements such as Cr, As, and Hf. (auth)

4771 (NYO-2394-28) AN EXPERIMENTAL STUDY OF THE STRENGTHENING MECHANISM AND FRACTURE BEHAVIOR OF

SPHEROIDIZED CARBON STEELS. Liu, C. T. (Brown Univ., Providence, R. I. Div. of Engineering). Aug. 1967. Contract AT(30-1)-2394. 145p. Dep. CFSTI.

The effects of grain boundaries and carbide particles on the strengthening mechanism and fracture behavior of spheroidized carbon steels ranging in carbon content from 0.065 to 1.46% are investigated. The spheroidized structure of the steel was obtained by quenching and tempering. The specimens were tested in tension to fracture at room temperature. The Petch type of strength-structure parameter equation is applied to the yield and flow properties of spheroidized carbon steels on the basis of different effective structural barriers (particles, grain boundaries and cell walls) in the various ranges of composition and strain. The mechanical behavior of low carbon steels (0.065 and 0.30%C) is similar to that of polycrystalline iron and the Petch form of the strength-grain size relation has been found to be equally applicable to both the yield and flow stresses. In medium and high-carbon steels (0.55 to 1.46%C), the strength data also satisfy the Petch equation based, however, on the particle spacing, which is believed to be associated with the dimensions of a dislocation cell structure formed during heat treatment and strengthened by deformation. The value of the Petch slope constant K increases from 1.15 to 1.95 Kg $mm^{-\frac{1}{2}}$ with increasing strain up to about 4% and then remains constant. This is interpreted as being due to the completion and intensification of dislocation cell walls by tangling of strain-generated dislocations, up to about 4% strain. The completion and intensification of dislocation cell walls at strain less than 4% leads to pronounced work hardening, but this particle-strengthening feature disappears at about 4% strain. At or above 4% strain a well-defined cell structure is believed to have formed. The flow data for both low carbon and medium and high carbon steels can be represented by the Petch relation with identical σ_0 and K values, where K has equal values for grain-boundary and cell-wall strengthening. The brittle carbide particles serve as the sites for crack initiation; the microcracks being initiated in the carbide particles or on the particle-matrix interfaces. In low carbon steels the interfacial cracks grow into barrel-shaped voids of dimensions determined by the spacing of carbide particles and grain boundaries. The ductile rupture of these steels is due to the coalescence of the barrel-shaped voids and the ductile rupture surface is characterized by dimples separated by sharply pointed walls. The growth of cracks is more restricted in medium and high carbon steels, where in general, the cavities and cracks are of the dimension of the particle diameter, and are stable as formed. In the necked region there are numerous cracks and cavities distributed uniformly throughout the cross section at fracture. The fracture of these steels is due to the slow propagation of noncrystallographic cracks which originate at interparticle cavities and intraparticle cracks. As a result, the ductile portion of the fracture surface is characterized by plane connecting facets between the cracks and cavities. A simplified model describing the fracture behavior of the medium and high carbon steels is proposed, which predicts that the fracture strength is inversely proportional to the square root of the slip distance, i.e., the particle spacing. The experimental data are in agreement with the predicted variation of fracture strength with the slip distance available in these steels. (auth)

4772 (ORNL-TM-1997) EVALUATION OF THE MOLTEN SALT REACTOR EXPERIMENT HASTELLOY N SURVEILLANCE SPECIMENS: FIRST GROUP. McCoy, H. E. Jr. (Oak Ridge National Lab., Tenn.). Nov. 1967. Contract W-7405-eng-26. 57p. Dep. CFSTI.

The first group of surveillance specimens from the Molten Salt Reactor Experiment core were removed after 7832 Mwhr of reactor operation during which the specimens were held at 645 ± 10°C for 4800 hr and accumulated a thermal dose of 1.3×10^{20} neutrons/cm^2. The high-temperature ductility was reduced, but the reduction was similar to that observed for these materials when irradiated in the Oak Ridge Reactor in a helium environment. The low-temperature ductility was reduced, and this is thought to be due to the formation of intergranular M_6C. The specimens showed no evidence of corrosion; however, a carbon-rich layer, 1 to 2 mils in depth, was noted where the Hastelloy N and graphite were in contact. The mechanical properties of the Hastelloy N appear adequate for the continued satisfactory operation of the MSRE. Test results are presented for the effects of several variables on the tensile ductility of irradiated and unirradiated Hastelloy N. These variables included test temperature, strain rate, and prestraining. (auth)

4773 (UCRL-7887) A CHEMILA EXPERIMENT IN BeO. Cline, C. F.; Newkirk, H. W.; Condit, R. H.; Hashimoto, Y. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 6, 1967. Contract W-7405-eng-48. 8p. (CONF-671038-1). Dep. CFSTI.

From Conference on Diffusion in Oxides, Washington, D. C.

The drift of ^{7}Be tracer in BeO at 1550°C under the influence of an externally applied dc electric field was determined by a sectioning technique. Reasonable agreement was obtained with the Nernst–Einstein relation. (auth)

4774 (WANL-TME-1370) CARBON DIFFUSION IN THE CARBIDES OF NIOBIUM. Brizes, Wm. F.; Cadoff, L. H.; Tobin, J. M. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Jan. 1966. Subcontract NP-1. 26p. Dep. CFSTI.

The reaction between niobium and graphite has been investigated at 700 to 2300°C. Parabolic growth behavior was observed for the Nb_2C and NbC phases. The rate constants for layer growth can be expressed as $K_{Nb_2C} = 0.3 \exp(-80.7 \text{ kcal/mole/RT})$ cm^2/sec and $K_{NbC} = 17.6 \exp(-96.2 \text{ kcal/mole/RT})$ cm^2/sec. It was demonstrated that niobium atom diffusion in the carbides is negligible compared to that for carbon. The carbon diffusivity in NbC was determined to be $D_{NbC}^{C} = 7.6 \exp(-88.2 \text{ kcal/mole/RT})$ cm^2/sec assuming that D is independent of concentration. The diffusivity of carbon in Nb_2C could not be accurately determined due to the lack of reliable high temperature phase equilibria data. Evidence is presented which suggests that the diffusivity in NbC decreases with increasing carbon composition. (auth)

4775 (WAPD-TM-712) NUMERICAL METHOD FOR DETERMINING STRAIN DISTRIBUTIONS IN A PLASTIC OR CREEPING MATERIAL UNDER INCREMENTAL LOADING. Friedrich, Carl M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sept. 1967. Contract AT(11-1)-Gen-14. 8p. Dep. CFSTI.

A numerical method is presented for determining strain distributions in a plastic or creeping material. The loading may be general, i.e., it need not be proportional. A revised form of the incremental stress-strain equations is given to reduce the number of iterations required in the solution. (auth)

4776 (NRC-TT-1295) ELECTROCHEMICAL MEASUREMENT OF OXYGEN DIFFUSION IN METALS AT HIGH TEMPERATURES. Rickert, H.; Steiner, R. Translated by D. A. Sinclair (National Research Council of Canada, Ottawa), from Z. Phys. Chem., (Frankfurt) (N.F.), 49: 127-37(1966). 13p. Dep. CFSTI. CAN.

An electrochemical method is described by which it is possible to measure oxygen diffusion in solid and liquid metals at high temperatures, using doped zirconium dioxide as a practically pure ion conductor for oxygen ions. A diffusion flow of oxygen is converted into an electric current. Potentiostatic measurement was found to be especially advantageous. Measurement in linear and cylindrical geometry is fully discussed. As a model, the oxygen diffusion coefficient is measured in solid silver between 760 and 900°C. The electrochemically measured diffusion coefficient agrees well with the value obtained by other methods. (auth)

4777 CHARACTERIZATION OF LARGE ALLOY SINGLE CRYSTALS BY NEUTRON DIFFRACTION. Ng, S. C.; Brockhouse, B. N.; Hallman, E. D. (McMaster Univ., Hamilton, Ont.). Mater. Res. Bull., 2: 69-73(Jan. 1967).

Study of the crystal dynamics of alloys by inelastic neutron scattering, which requires large alloy single crystals, can provide data on lattice constants, compositions, and homogeneities. Neutron diffraction offers a simple way of obtaining these characterizations, and alloy characterizations are determined as an average over the whole crystal instead of, as is usually the case for x-ray and chemical analysis, over a specific small part of the crystal. Measurements were made on alloy crystals from the systems: Pb–Tl, Bi–Tl, Cu–Zn, Cu–Au, Cu–Ni, and Ni–Fe. Crystals of the pure metals, Pb, Cu, and Ni, were used for calibration. Lattice constants were determined by running a family of rocking curves for a given lattice plane of the specimen at different closely spaced scattering angles. A plot of the peak intensity for each rocking curve vs the scattering angle established the scattering angle for the Bragg condition. The lattice constants were determined to an accuracy of about 2 parts in 10^4. Because the large neutron beam takes in and penetrates almost the whole ingot, the lattice constants obtained characterize the mean composition of the ingot and the spreads in lattice constant characterize its homogeneity. (BBB)

4778 MAGNETIC PROPERTIES OF INTERMETALLIC COMPOUNDS BETWEEN THE LANTHANIDES AND PLATINUM. Wallace, W. E.; Vlasov, Y. G. (Univ. of Pittsburgh). Inorg. Chem., 6: 2216-19(Dec. 1967).

The magnetic properties are reported for a series of intermetallic compounds designated by the formula $LnPt_2$ in which Ln represents Pr, Nd, Gd, Tb, Dy, Ho, or Er. All have the C15 ($MgCu_2$) structure. Emphasis was placed on the paramagnetic region. The effective moment (μ_{eff}) for the paramagnetic $LnPt_2$

compounds is fairly close to $g\sqrt{J(J+1)}$, the value for the free tripositive Ln ion. In $GdPt_2$ μ_{eff} exceeds this by about 2%, which is ascribed to conduction electron polarization effects. The measured μ_{eff} values indicate that Pt in the $LnPt_2$ series is nonmagnetic. Curie–Weiss behavior was observed at all temperatures down to the Curie temperature indicating a relatively weak crystal field interaction. The low moment observed for the samples in the ferromagnetic state is ascribed to failure to achieve saturation. All except $PrPt_2$ became ferromagnetic at 4.2°K. $PrPt_2$ may be a Van Vleck paramagnet at this temperature. (auth)

4779 STRAIN-ANNEAL GROWTH OF LARGE GRAINS IN A GALLIUM-STABILIZED DELTA-PLUTONIUM ALLOY. Nurminen, J. I. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Trans. Amer. Nucl. Soc., 10: 475-6(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4780 DUCTILITY AND MATRIX CONSTITUTION OF SINTERED W–Ni–Fe ALLOYS. (FIRST REPORT ON PROPERTIES OF HEAVY METAL COMPOSITES). Takeuchi, Hisasuke. Nippon Kinzoku Gakkai, 31: 1064-70(1967). (In Japanese).

Influence of Ni/Fe ratio on the ductility of W–Ni–Fe heavy metals was studied. Sintered 95% tungsten alloys were prepared, using coreduced fine powder, with the varying Ni/Fe ratios of 1/9, 3/7, 5/5, 7/3, 8/2 and 9/1. In the case of alloys made by liquid-phase sintering, the optimum strength and ductility, as well as the lowest micro-hardness in matrix, were obtained in the Ni/Fe ratios from 5/5 to 7/3. The alloys made by solid-phase sintering were comparatively hard and less ductile. In most of the W–Ni alloys and W–Ni–Fe alloys with the Ni/Fe ratios less than 3/7, two phases were observed in the bonding matrix. It is to be noted that these alloys were relatively less ductile. Electron probe microanalysis of 80% W–Ni–Fe alloys revealed that the tungsten content in the matrices changed with the Ni/Fe ratio, reaching the minimum at the Ni/Fe ratio of 7/3. It was concluded that the high ductility of W–Ni–Fe alloys was obtained when there was little tungsten dissolved in the matrix and no brittle phase was contained in the system. (auth)

4781 EMISSION PROPERTIES OF CATHODES PREPARED FROM HIGH-TEMPERATURE ALLOYS. Budinchevich, A. Radiotekh. Elektron., 12: 1255-60(July 1967). (In Russian).

Studies on the thermoelectric converters, filled with inert gases, with specific neutralization of the space charge, were necessary for the development of new types of cathodes. Experiments were carried out with rare earth metals and their alloys, introduced in tungsten matrix. The emission properties of the new systems of metallic alloys La–Th–W and La–W–Zr were analyzed; the volt-ampere characteristics were deduced and the volatility was studied. Data were obtained on the output work and the Richardson emission constant for these cathode materials. An hypothesis for the explanation of their emission properties was proposed. A new procedure for the production of materials for cathodes of large dimension from these alloys with high melting temperature was developed. The results of the experiments were reported. (J.S.R.)

4782 EMISSION AND ADSORPTION PROPERTIES OF BINARY METALLIC ALLOYS. Druzhinin, A. V. Radiotekh. Elektron., 12: 1265-9(July 1967). (In Russian).

The dependence of the electron yield output from binary metallic alloys was investigated using an emission microscope. The investigation of all alloys systems was made on single samples. The necessary distribution of the concentrations of the components was attained by diffusion. In the case of metals such as W–Re, Re–Mo, and Re–Ta, emission effects, causing a reduction in the yield output, were not observed. The migration of barium in samples of variable composition was investigated. An accelerated migration of barium with respect to sheets of intermetallic compounds was detected. (tr-auth)

4783 THERMOELECTRON EMISSION OF YTTRIUM, SCANDIUM, AND ERBIUM. Savitskii, E. M.; Terekhova, V. F.; Maslova, E. V. Radiotekh. Elektron., 12: 1320-1(July 1967). (In Russian).

The effective yield output of Y, Sc, and Er was determined by measurement of the thermoelectron emission current in a vacuum. The metals were purified by distillation and then remelted in a vacuum by electron beam and then cold-rolled into foils with thickness of 200 μ. The thermoelectron emission was measured at temperatures from 1150 to 1400°K for Y and up to 1500°K for Sc and Er. The dependence of the effective yield output on the temperature is shown graphically. At 1300°K the values are 2.98, 3.23, and 3.06 for Y, Sc, and Er, respectively. (J.S.R.)

4784 UDIMET M-252 (HIGH-TEMPERATURE ALLOY). Alloy Dig., Ni-124: 2p(May 1967).

UDIMET M-252 is a vacuum induction method alloy (Ni-base, 18 to 20% Cr, 9 to 11% Co and 9 to 10.5% Mo) recommended for heavy duty high-temperature applications at 1300 to 1600°F. It has good stress rupture strength, fatigue strength and tensile strength at elevated temperatures. The alloy responds to an age hardening heat treatment. It has good resistance to corrosion in jet engine-type gaseous atmosphere up to 1600°F. Applications are heavy-duty jet engine and gas turbine buckets, high-temperature bolting, jet engine turbine wheels and other critical jet engine components. (Rev. Met. Lit.)

4785 CHEMISORPTION OF CARBON MONOXIDE ON MOLYBDENUM. Crowell, A. D.; Matthews, Lee D. Surface Sci., 7: 79-89(May 1967).

The chemisorption of CO on polycrystalline Mo has been studied using a radiotracer technique. Following outgassing at temperatures of 1500 to 2000°K in an ultrahigh vacuum system, CO tagged with ^{14}C was admitted to pressures in the 10^{-8} to 10^{-5} torr range. Rates of adsorption were consistent with sticking coefficients in the range of 10^{-3} to 10^{-1}. Desorption at various temperatures was observed as a function of time, and the data are interpreted in terms of a set of several binding states corresponding to desorption energies of 3.24 ± 0.03, 3.41 ± 0.03, 3.61 ± 0.02, 3.77 ± 0.03 and 3.95 ± 0.02 eV. The relative population of these states at saturated coverage was also determined, and the differential energy of desorption as a function of coverage and temperature has been calculated. (Rev. Met. Lit., August 1967)

4786 THE CREEP BEHAVIOUR OF HEAT-TREATED MAGNOX ZR-55 IN THE TEMPERATURE RANGE 350 TO 450°C. Pickles, B. W. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). J. Inst. Metals, 95: 333-7(Nov. 1967).

At high stresses, testing atmosphere has a marked influence on the creep strength of heat-treated ZR-55. The strength of specimens tested in air was increased by hydrogen pick-up and the consequent formation of zirconium hydride led to creep rates substantially lower than those obtained in CO_2. At low stresses, however, no atmospheric effect was observed, and the data obtained suggest that diffusion creep is the predominant mode of deformation. A metallographic method was devised to test this hypothesis and has given results in good agreement with the Nabarro-Herring theory of diffusion creep. (auth)

4787 LIQUID SODIUM. Addison, C. C. (Univ. of Nothingham, Eng.). Endeavour, 26: 91-5(May 1967).

The properties of liquid sodium have recently become important theoretically, because it is an interesting non-aqueous solvent, and practically, because it is used as a coolant in fast nuclear reactors. Many of the properties of solutions in this medium are so unusual that they can be understood only if it is assumed that the atoms of a liquid have some structural order. This article discusses the properties of the solutions, and some evidence for the existence of order in the liquid phase. (auth)

4788 EFFECT OF BORON ON THE STRUCTURE AND MECHANICAL PROPERTIES OF NICKEL. Amonenko, V. M.; Azhazha, V. M.; Bolgov, I. S.; Zeidlits, M. P.; Shapoval, B. I.; Rybal'chenko, N. D. Izv. Akad. Nauk SSSR, Metal., No. 4, 140-6(July-Aug. 1967). (In Russian).

The effect of B on vacuum-remelted high-purity N–O nickel was investigated by producing in a vacuum induction furnace Ni–B alloys containing 0.005, 0.01, 0.05 and 0.1 wt % B and investigating the mechanical properties and pattern of fracture of specimens of these alloys at 20 to 700°C following their annealing at 800°C for 2 hr. In addition the specimens were metallographically and structurally examined, and investigated for internal friction. On this basis, it is established that boron enhances the interatomic bonding forces in the lattice, reduces the diffusion mobility of atoms and vacancies and increases resistance to plastic deformation and, particularly, to creep. Further, B favorably affects the structure of Ni by reducing the dimensions of crystallites during primary recrystallization, raising the initial temperature of recrystallization and reducing the grain growth rate during accumulative recrystallization. It also reduces the dislocation density and contributes to the formation of a stable substructure. It has a refining effect on nickel and it enhances the strength of grain boundaries by neutralizing the harmful effect of readily fusible impurities, since, owing to its surface activity, it gets chiefly localized along grain and subgrain boundaries and other interfaces. This apparently is the reason for the change in the pattern of fracture of nickel under conditions of creep, from brittle intergranular fracture (original nickel) to ductile intragranular fracture (boron-treated nickel) and the increase in the total margin of plasticity. The highest plasticity is displayed by nickel containing 0.01% B. The somewhat lower plasticity of nickel containing 0.05 to 0.1% B is apparently due to the embrittling effect of secondary phases-borides. (ATD)

4789 EFFECT OF ALLOYING ELEMENTS ON THE STRENGTH AND PLASTICITY OF TITANIUM AT TEMPERATURES FROM −196 TO 800°C. Ul'yanov, R. A.; Kovtun, S. F. Izv. Akad. Nauk SSSR, Metal., No. 4, 117-21(July−Aug. 1967). (In Russian).

The effect of rhenium, tantalum, palladium, and lanthanum on the strength and plasticity of titanium at −196 to +800°C has been investigated. The specimens were melted from vacuum-refined titanium sponge and high-purity alloying elements in an argon-atmosphere arc furnace and tested at high temperatures in vacuum and at low temperatures in liquid nitrogen. It was found that the tensile strength and elongation of commercial titanium increased from 45 kg/mm² and 23% at room temperature, to 95 kg/mm² and 26% at −196°C. The addition of 1% lanthanum increased the alloy elongation to 40% but reduced it to 20% in alloy with 2.2% lanthanum at −196°C. The tensile strength of titanium alloyed with up to 1.8% palladium was higher by 5 to 20% at all low temperatures and exceeded 80% at 550 to 600°C; the elongation of this alloy dropped at all temperatures. Alloying with up to 13% tantalum increased the strength of titanium alloy at low and high temperatures, particularly between −196 and 250°C; at higher temperatures the strength of the alloy dropped to that of pure titanium. The strength of titanium−rhenium alloy increased at low and particularly at high temperatures, with the exception of alloy with 3% rhenium in which the strength dropped below that of titanium at −196°C. The elongation of Ti−Re and Ti−Ta alloys with increasing alloying element concentration dropped at temperatures from −196 to 550°C and started to increase at about 750°C. (ATD)

4790 ELASTIC PROPERTIES OF BINARY ALLOYS OF NIOBIUM WITH TUNGSTEN, MOLYBDENUM, IRON, AND NICKEL. Nedyukha, I. M.; Chernyi, V. G. Izv. Akad. Nauk SSSR, Metal., No. 4, 168-79(July-Aug. 1967). (In Russian).

The elastic constants of the alloys of Nb with W (0-100 at. % W), Mo (0-100 at. % Mo), Fe (0-45.4 at. % Fe), and Ni (0-40.4 at. % Ni) are discussed. The curves plotted show that in Nb−W and Nb−Mo alloys an increase in the content of W and Mo leads to an increase in E, G, Q, Θ and a decrease in μ and $\sqrt{\bar{u}^2}$. It is established that for Nb−W and Nb−Mo the characteristic temperature Θ cannot serve as an unambiguous criterion of the strength of interatomic bonding; in this respect, E and $\sqrt{\bar{u}^2}$ are more reliable criterions. As for Nb−Fe and Nb−Ni alloys, it is found that the effect of Fe and Ni on the increase in E, G, Θ and decrease in $\sqrt{\bar{u}^2}$ is virtually the same, while the values of Q and μ in Nb−Ni alloys are several times as high as in Nb−Fe alloys. But while in Nb−W and Nb−Mo alloys the increase in E and Θ and decrease in $\sqrt{\bar{u}^2}$ are associated with an increase in the strength of interatomic bonding, in Nb−Fe and Nb−Ni alloys these changes in E, Θ and $\sqrt{\bar{u}^2}$ are associated with the increase in the quantity of regions with a higher level of interatomic bonding, i.e., the increase in the amount of the second phase. Thus the comparatively low values of elastic characteristics of niobium, which account for the shortcomings of this metal as a structural material, may be markedly improved by treating it with alloying elements so as to either enhance the interatomic bonding strength of its crystal lattice or to trigger the formation of excess phases with high elastic characteristics. (ATD)

4791 FRACTURE OF STRUCTURAL MATERIALS. Tetelman, A. S.; McEvily, A. J. Jr. Wiley Series on the Science and Technology of Materials. New York, John Wiley and Sons, Inc., 1967. 709p.

The mechanics of fracture of structural materials is described. The principles that structural and design engineers should follow in designing with and testing various types of brittle materials are discussed. The process of fracture is treated as macroscopic and microscopic aspects of fracture, the relation between microscopic and macroscopic aspects of plain-strain fracture, time-dependent fracture, and fracture of specific materials. (R.C.K.)

4792 A STUDY OF THE INFLUENCE OF MICROSTRUCTURE ON THE MECHANICAL BEHAVIOR OF A MOLYBDENUM−TITANIUM−CARBON ALLOY. Thompson, John Russell Jr. Bethlehem, Pa., Lehigh Univ., 1966. 73p.

Thesis.

A study was initiated to investigate the influence of microstructure on the mechanical behavior of a molybdenum−0.5% titanium−0.03% carbon alloy produced by powder-metallurgical techniques. The results of the room temperature tests suggest that the relation between the yield strength of the alloy and the microstructure can be described by the Petch relation: $\sigma_{y.s.} = \sigma_0 + k_y L^{-\frac{1}{2}}$, where L is the fiber width. Values of σ_0 k_y agree with similar published data relating yield strength and grain size for molybdenum. With the aid of the power law, it was found possible to predict the theoretical stress-strain behavior of the alloy. It was also found that the rate of strain-hardening and the strain-hardening exponent approach limiting values as the fiber width becomes smaller. From the elevated temperature test results, no benefit appeared to be derived by including a 1700°C in-process heat-treatment in the fabrication schedule. The stress-relieved materials were stronger than the as-rolled 40-mil sheet for the elevated test temperatures investigated. Metallographic examination of the materials after tensile testing at 1000 to 1200°C revealed that recrystallization had apparently begun on a large scale in the as-rolled materials while only slightly in the stress-relieved materials. This difference in the microstructure would be sufficient to cause the observed difference in strength. Crystallographic texture analysis of all materials used in the program indicated that the strengthening observed for this alloy was not the result of preferred orientation. (Disser. Abstr.)

4793 INVESTIGATION OF HYDROGEN AND DEUTERIUM ABSORPTION BY ALLOYS OF PALLADIUM WITH PLATINUM AND WITH GOLD. Maeland, Arnulf Julius. Burlington, Vt., Univ. of Vermont, 1966. 134p.

Thesis.

The course of H_2 and D_2 absorption from dilute acid solutions by palladium-rich alloys has been followed by changes occurring in their electrode potentials and in their relative resistances. Absorption isotherms have been constructed from the electrode potentials and from relationships established between relative resistances of the alloys and their H (D) content (25°C). Lattice constants have been determined as a function of both the H and D content of the alloys. Phase boundaries have been established using x-ray diffraction techniques. In the Pt−Pd−D system pressure invariant regions for alloys with 8.80% Pt were observed at 25°C, 1 atm. D_2. In analogy with pure Pd these pressure invariant regions correspond to the coexistence of the α- and β-nonstoichiometric hydride phases. The two-phase region persists up to about 14% Pt in the Pt−Pd−H system. A large isotopic solubility difference between H_2 and D_2 is found at about 9% Pt (25°C, 1 atm.). The negative heats of absorption in the two-phase region of the Pt−Pd−D system, determined for each alloy from the temperature coefficient of the two-phase electrode potential, show a linear decrease with Pt content from 8551 cal/mol for pure Pd to 6828 cal/mol for the 5.75% Pt alloy. The corresponding values with H_2 are 9546 and 7462 cal/mol. The experimental difference (995 cal/mol) between the heats of absorption of H_2 and D_2 in Pd is in good agreement with the predicted value for this difference (1126 cal/mol). The negative free energy change for the $\alpha \rightarrow \beta$ transition becomes progressively smaller, in the Pt−Pd−D system as well as in the Pt−Pd−H system, as the percentage of Pt increases. The difference in isotopic solubility is understandable in terms of the thermodynamic parameters. The variation of lattice spacings with composition has been determined for the Au−Pd system. A small negative deviation from the simple linear dependence on composition predicted by Vegard's law has been observed. The maximum deviation occurs at about 60% Au and is related to changes in the electronic structure of Pd. Addition of Au to Pd causes effects on the H_2 absorption characteristics of Pd such as an increase in solubility at low pressure; a decrease in the $\alpha \rightarrow \beta$ transition pressure; an increase in the heat of solution; and a decrease in equilibrium solubility at 25°C, 1 atm. H_2. These results are discussed in terms of an extension of a statistical model, proposed for the Pd−H system, in which hydrogen is assumed to dissolve as protons with the electrons going into empty d-states in the conduction band. The first three effects are attributed to an increase in the attractive interaction energy between the protons and the interstitial sites, and the last effect is due to a decrease in the number of available electron states in the d-band. (Disser. Abstr.)

4794 PARAMETERS AFFECTING THE MECHANICAL BEHAVIOR OF TUNGSTEN: GRAIN BOUNDARY STRUCTURE AND ALLOY ADDITIONS OF CARBON AND RHENIUM. Hay, Donald Robert. Ithaca, N. Y., Cornell Univ., 1966. 117p.

Thesis.

The mechanical properties of tungsten are sensitive to the grain structure and to composition as well as to such test conditions as temperature and strain-rate. The roles of grain boundary structure and chemical additions to the tungsten matrix were examined. The effect of the degree of misorientation (mosaic spread) between grains on the resolved shear stress at the proportional limit was studied. The stress increased with mosaic spread in the range of misorientations where the grain boundary structure changed from low angles where it is best described by simple dislocation models to high angles where it is characterized by high atomic misfit. This occurred in the range 2° to 10°. The Petch slope calculated from the experimental data using a $\sqrt{\theta}$ dependence of the Petch slope on the misfit angle θ agreed to within an order of magnitude with those predicted theoretically. Deviations from the theoretical were attributed to stabilization of the

boundary by interstitial impurity elements. Chemical interactions of rhenium and carbon with the tungsten matrix were studied by observing changes in shear modulus with composition. The addition of 3% rhenium to tungsten decreased the shear modulus from 19.6×10^6 psi to 16.1×10^6 psi. Carbon additions did not change the modulus of the pure tungsten, but 70 ppM carbon increased that of the alloy to 18.7×10^6 psi. The observed alloying behavior was correlated to the electronic structure. The changes in modulus were attributed to changes in the electronic structure of the metal upon alloying. Differences in the behavior of carbon in the pure tungsten and the alloy were related to an increased carbon solubility in the alloy which in turn is a function of the electronic structure of the metal. (Disser. Abstr.)

4795 HIGH TEMPERATURE AND CRITICAL PROPERTIES OF CESIUM. Hochman, Jack M. New York, Columbia Univ., 1964. 155p.

Thesis.

The electrical resistance of a capsule containing equilibrium liquid and vapor cesium was measured as a function of length enabling the determination of liquid level from the difference in resistance per unit length of the sections containing liquid and vapor. From two such measurements with different amounts of charged cesium the equilibrium liquid and vapor densities of cesium were obtained at temperatures approaching the critical point. The resistance per unit length across the liquid section of the capsule enabled the determination of the electrical resistivity of liquid cesium using the equation for parallel conductors. Lorenz's law was then utilized to calculate the thermal conductivity of liquid cesium from the electrical resistivity. These results were then used to estimate the critical temperature and density of cesium by four independent methods. The critical pressure was then obtained by extrapolation of low temperature vapor pressure equations. The critical properties obtained were: $T_c = 3675°F$, $d_c = .445$ g/cc, $P_c = 134.8$ atm. Using the critical properties of cesium as reference, the critical properties of rubidium, potassium and sodium were estimated by comparison of the available low temperature electrical resistivity and liquid density data for these metals with that of cesium. (Disser. Abstr.)

Structure and Phase Studies

Refer also to abstracts 4742, 4743, and 4792.

4796 (CEA-R-3275) DIFFUSION DANS LE SYSTEME PLUTONIUM ZIRCONIUM. (Diffusion in the Plutonium Zirconium System). Lauthier, Jean-Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). July 1967. 80p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

Intermetallic $PuZr_2$ cannot be obtained by a direct synthesis. The formation is probably due to oxygen enhancement of diffusion processes by a contribution of bound extrinsic vacancies. Results of investigation of a range of alloys from 15 to 50 at.% Pu pointed out the nature of the isothermal transformation. It takes place at 615 ± 5°C and is of the peritectoid type. Pu ϵ (bcc) + Zrα (hex) $\rightleftharpoons$ Pu δ (fcc). Diffusion coefficients have been determined from couples made of PuZr dilute alloys (1.15 and 0.115 at.% Pu) and pure zirconium; these couples have been annealed at 700 to 840°C from 1000 to 3000 hours. The curves C = f (x) were plotted by x ray microanalysis and α autoradiography. They have been analyzed assuming that the diffusion coefficient was constant. Results are: DZrPu (1.15% = 11.1 e − 65,000/RT. DZrPu (0.115%) 0.1 e − 54,000/RT. (auth)

4797 (NMI-TJ-37) STABILITY OF THE HIGH-TEMPERATURE PHASE IN BERYLLIUM AND BERYLLIUM ALLOYS. Gelles, S. H.; Pickett, J. J.; Levine, E. D.; Nowak, W. B. (Nuclear Metals, Inc., Concord, Mass.). Mar. 30, 1961. Contract AT(30-1)-1565. 22p. Dep. CFSTI.

An investigation is in progress to determine the stability and mechanical properties of the body-centered cubic phase that exists just below the melting point of Be rich alloys. Differential thermal analysis (DTA) has been applied to alloys of Be in each of the following systems: Ce, Cr, Co, Cu, Fe, La, Mn, Ni, Nb, Pd, Pt, Si, Ag, V, Zr, Co−Ni, Cu−Ni, Fe−Ni, Ni−Pd, Co−Fe−Ni, and Co−Mn−Ni. The DTA has established fairly well the beta phase field in the systems of Be with Cr, Co, Cu, and Ni; tentative beta phase fields have been constructed for the systems Be with Fe, Mn, Si, and Ag. The remaining systems are still being studied. The phase diagrams are of two classes: enlarged beta field, and closed beta field. For this investigation, primary interest is with enlarged-field systems such as Be with Co, Cu, and Ni. A correlation has been found between the beta−alpha upper solvus transition temperatures and electron-to-atom ratios for alloys of Be with Co, Cu, Fe, and Ni. Suppression of the beta−alpha transformation temperature by quenching is being measured using a modified Greninger He-gas apparatus. Initial cooling rates up to 60,000°C/sec have been observed. At elevated temperature, the beta-phase structure appears to be more ductile than the alpha-phase structure. A Be-8 at.% Ni alloy exhibited 20 percent reduction in area in tensile tests at 1070°C (at which temperature the alloy is mostly beta). Unalloyed Be exhibited zero reduction in area at this temperature. (auth)

4798 (RLO-1375-5) PHASE TRANSFORMATIONS IN A EUTECTOID BINARY ALLOY SYSTEM. Progress Report No. 8. (Washington Univ., Seattle. Coll. of Engineering). Oct. 15, 1967. Contract AT(45-1)-1375. 52p. Dep. CFSTI.

A study has been made of the effects of alloy constitution on the electrical properties of Ti−Cr binary alloys. The utilization of electrical resistance measurements to explore the beta to omega reaction constitutes a major portion of this work. The problem of developing an explanation for the observed negative value of $d\rho/dT$ has received special attention. Measurements have been conducted on alloys containing up to 12 atom percent Cr in both the as-quenched and the quenched and aged conditions. The negative value of $d\rho/dT$ in Ti−Cr alloys has been identified solely with the retained beta phase and appears to be independent of the omega reaction. A model based on the concept of a relative shift in the s and d bands in alloyed titanium has been developed to explain the anomalous negative temperature coefficient of resistivity. The variation of the temperature coefficient of electrical resistivity has been used to monitor the structural changes that accompany the nucleation of the omega phase during aging. The initial stages of aging are identified by a constant value of $d\rho/dT$ and a simultaneous increase in resistivity, while the later stages of aging are accompanied by an increasing positive value of $d\rho/dT$. Electron transmission microscopy provides the principal means for studying phase transformations with particular emphasis on metastable high purity Ti−Cr binary alloys. The fine structure of the HCP martensite in Ti and alloys containing 2.4 to 5.9 at. % Cr has been investigated, and the results have been interpreted. The habit plane, orientation relations, and lattice correspondence for the acicular martensite formed in Ti−Cr alloys has been found to remain independent of Cr content. Some of the fine structure in the Ti−Cr martensite has been identified with twinning. The crystallographic theory does not predict this twin mode for lattice invariant deformation, and it has been attributed to accommodation occurring within a martensite plate during transformation. The spontaneous transformation of the metastable beta phase in Ti−Cr alloys during thinning has also received further study. (J.C.W.)

4799 TRANSFORMATION UNDER HIGH PRESSURE OF THE HEXAGONAL FORM OF $MnT'O_3$(T' = Ho, Er, Tm, Yb, Lu) INTO A PEROVSKITE FORM. Waintal, A.; Chenavas, J. (CNRS, Grenoble, France). Mater. Res. Bull., 2: 819-22(Aug. 1967). (In French).

The compounds $MnT'O_3$ have the perovskite structure for the lighter rare earths (up to Dy), crystallizing in the space group Pbnm; those above Ho have a hexagonal structure of the space group $P6_3cm$. Under pressure the Ho compound transforms into the perovskite structure. It is now reported that the higher rare earth compounds may be transformed into the perovskite structure under the influence of both heat and pressure. Thus the Ho compound is transformed at 45 kB, and 950°C; Er, 42 kB, 675°C; Tm, 42 kB, 780°C; Yb, 42 kB, 700°C; and Lu, 42 kB, 750°C. All were heated for 2 hr, and all gave nicely crystalline samples except for the Lu compound. Crystal parameters, molecular volume, and variation in volume from perovskite to hexagonal structure are given. The indices for $MnLuO_3$ are given as an example. If the perovskite samples are heated at 1000°C for 4 hr at atmospheric pressure, they return to the hexagonal form, but this is not the same as the inverse of the hexagonal-perovskite transformation. (BBB)

4800 X-RAY AND SPECTROGRAPHIC INVESTIGATIONS OF PHASE TRANSITIONS IN REFRACTORY OXIDES (ZrO_2 AND RARE-EARTH OXIDES). Glushkova, V. B.; Koehler, E. K. (Inst. of Silicate Chemistry, Leningrad). Mater. Res. Bull., 2: 503-13(May 1967).

Phase transformations in rare earth oxides and polymorphism of zirconium dioxide are studied. X-ray methods (at room and high temperatures), molecular spectroscopy, thermal analysis, thermogravimetric analysis, and phase-shift chemical analysis were performed to provide data on the mechanism and kinetics of these physiochemical processes. Characteristics of the tetragonal form of ZrO_2 (not previously known to be quenched without stabilizing additions) were determined. It was shown that the rare earth oxides form extensive solid solutions in ZrO_2. The solubility of the rare-earth oxides in the monoclinic ZrO_2 amounts to not more than 2 mole % (at 500 to 900°C) and in the tetragonal phase 3 to 4 mole % (at about 1600°C). The temperature of the monoclinic-tetragonal transformation of the ZrO_2 solid solution decreased with increasing content of rare earth oxides. Parameters of the unit cells of ZrO_2

and the ZrO_2-based solid solutions were calculated for the temperature range from the room temperature to 1500°C. The monoclinic-tetragonal transformation of ZrO_2 is followed by shrinkage and the reverse transformation on cooling is followed by expansion. For pure ZrO_2, the volume change calculated from x-ray data was 8 to 9%, for the solid solution containing 5 mole % Nd_2O_3 5.6%, and for the solid solution with 1 mole % Eu_2O_3 about 4%. The volume changes occurring on the monoclinic-tetragonal transformation were not only smaller but took place over a wider temperature range. (BBB)

4801 DIRECT OBSERVATION OF THE SUPERLATTICES OF Ta_2O_5 AND Nb_2O_5 IN THE ELECTRON MICROSCOPE. Spyridelis, J.; Delavignette, P.; Amelinckx, S. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Mater. Res. Bull., 2: 113-20(Jan. 1967).

Thin foils of Nb and Ta pentoxide, prepared by recrystallization of amorphous films, and which have so-called shear structures, were examined by transmission electron microscopy. The long spacing observed in these oxides, as well by direct imaging, as by electron diffraction, was found to depend on the mode of preparation, in particular on the ambient during recrystallization. A striking feature of the diffraction pattern, referred to as the spacing and orientation anomaly, was most pronounced in Nb_2O_5, but also present in Ta_2O_5. From the diffraction patterns it was evident that the superlattice spots were not part of a linear sequence with a constant spacing. It was verified that the pattern corresponds to a single layer of the reciprocal lattice. This observation suggests that the superlattice spots do not form a lattice but that the crystal should in fact be considered as a grating of gratings. A model which accounted qualitatively for these observations is presented. The crystal would consist of narrow strips (i.e., of a width equal to the superlattice spacing), within which the crystal would have a structure with a small unit cell giving rise to the main spots. The narrow strips are only a limited number of such unit cells wide (~22 in Ta_2O_5); moreover, this number is not rigorously constant for different strips as judged from the variability of the fringe spacing. The regular repetition of such strips gives rise to a supergrating of which the line spacing is slightly variable and which contains a number of strips equal to the observed number of lines within a subgrain. The model accounts for the small orientation anomaly; the low index planes of the superstructure, i.e. the direction of the fringes need not be parallel to the low index planes of the structure within the blocks. The finite length of the linear sequences of superlattice spots is presumably due to the slight variability in superlattice spacing. (BBB)

4802 PORE MIGRATION IN CERAMIC FUEL ELEMENTS. Nichols, F. A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 463(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4803 THERMODYNAMIC PROPERTIES OF SOLID AND LIQUID METAL ALLOYS AND THEIR RELATION TO PHASE DIAGRAMS. Gerasimov, Ya. I. (Moscow State Univ.). Zh. Fiz. Khim., 41: 2441-57(Oct. 1967). (In Russian).

Thermodynamic properties, heat of formation of alloys of pure components, complete and excessive changes of isobar potentials, entropy of dissolution, and activity coefficients of components were studied using Mg-Ca, Cu-Pd, Ge-Si, In-Te, Co-Mo, Fe-Sb, Mn-V, Fe-Pt, Cu-Ni, Cu-Sb, Ag-Sb, Cd-V, Cd-Bi, Cd-In, and Zn-Ge alloys. (R.V.J.)

4804 THE ATOMIC DIAMETER OF THE RARE-EARTH METALS IN SOME SELECTED CUBIC INTERMEDIATE PHASES AND HEXAGONAL SOLID SOLUTIONS. Harris, I. R.; Mansey, R. C. (Univ. of Birmingham, Eng.). J. Less-Common Metals, 13: 591-602(Dec. 1967).

The lattice spacings of a number of cubic intermediate phases and cph solid solutions containing rare-earth metals have been examined in order to obtain an estimate of the atomic diameter of the particular rare-earth component. (auth)

4805 METASTABLE HEXAGONAL CLOSE-PACKED PHASES IN Ni-RICH Ni-Nb AND Ni-Ta ALLOYS. Ruhl, R. C.; Giessen, B. C.; Cohen, M.; Grant, N. J. (Massachusetts Inst. of Tech., Cambridge). J. Less-Common Metals, 13: 611-18 (Dec. 1967).

Utilizing a splat-cooling technique, Ni-N' and Ni-Ta alloys with compositions from 15 to 25 at. % Nb or Ta have been rapidly quenched from the melt. Four new metastable structural features involving metastable phases were identified, the most significant of which was the production of hcp (Mg-A3) ζ phases in both systems. Other new effects found were the extensions of α-Ni solid solutions to higher solute contents; the extension of the $NbNi_3$ solid solution to lower Nb contents; and the production of microcrystalline phases, especially at higher cooling rates. The ζ phase is structurally related to $NbNi_3$ and $TaNi_3$. Arguments for the occurrence of ζ, based on average group number and on valence-electron concentration estimates, are presented. (auth)

4806 OBSERVATION OF DISLOCATIONS IN DEFORMED MOLYBDENUM CRYSTALS. Loesch, H. W. Jr.; Brotzen, F. R. (Rice Univ., Houston, Tex.). J. Less-Common Metals, 13: 565-78(Dec. 1967).

Molybdenum crystals deformed in direct shear on the $(1\bar{1}0)$ [111] system were examined by transmission electron microscopy. The dislocation structures, dislocation and jog densities were determined as a function of shear strain and deformation temperature at 78 to 373°K. The mobility of edge dislocations is greater than that of screw dislocations, but this difference is diminished with rising temperatures and strains. Motion of screw dislocations is impeded by jogs, and appreciable conservative motion of these jogs at higher temperatures helps to relieve this immobility. The flow stress is a linear function of the square root of the dislocation density. Though no cells tend to form, tangling is pronounced at all temperatures. It appears that tangles originate at small precipitates and at the grown-in dislocation network. (auth)

4807 THE CRYSTAL STRUCTURE OF SOME BINARY ALLOYS OF TECHNETIUM WITH TRANSITION METALS. Niemiec, J. (Inst. of Inorganic Chemistry and Metallurgy, Wroclaw. First State Polytechnic, Wroclaw). Nukleonika, 10: Suppl., 23-9(1965). (In Polish).

From 1st National Symposium on Nuclear Chemistry, Warsaw, Feb. 10-12, 1964. See CONF-640210.

To characterize the crystallo-chemical behavior of Tc alloys with transition metals, the following phase equilibria were examined: Mo-Tc, Tc-W, Re-Tc, Os-Tc, Ru-Tc, Rh-Tc, Pd-Tc, Pt-Tc, Cu-Tc, Ag-Tc, and Au-Tc. About 70 different compositions, each weighing 20 and 30 mg, were prepared by sintering in H_2 or in a vacuum and were examined by x-ray methods. The σ-type intermetallic phases were found in Mo-Tc and Tc-W systems only. In Mo-Tc, the β-phase, as well as the σ-phase, was noted. With Re, Ru, and Os, Tc was found to yield continuous solid solutions. In systems with the remaining Pt metals, the existence of limiting solid solutions was found. The phase diagrams of Tc with transition metals were compared with analogous Re systems. Crystallochemical aspects of Tc alloys are discussed with the emphasis on electronegativity, atomic volumes, and the Brillouin theory. (auth)

4808 PHASE DIAGRAM OF THE MOLYBDENUM-BORON SYSTEM. Portnoi, K. I.; Levinskii, Yu. V.; Romashov, V. M.; Mordovin, O. A.; Levinskaya, M. Kh. Izv. Akad. Nauk SSSR, Metal., No. 4, 171-76(July-Aug. 1967). (In Russian).

A series of molybdenum-boron alloys containing up to 95% boron has been investigated. The alloys were melted from 99.6%-pure molybdenum and 99.4%-pure boron. On the basis of obtained results a phase diagram of the molybdenum-boron system was plotted. With boron content above 20 at. %, molybdenum and Mo_2B formed eutectic at 2200°C. The solubility of boron in molybdenum at 2200°C was about 1 at. %. The solidus temperature of an alloy containing 1 at. % boron was 250°C higher than the eutectic temperature. Mo_2B phase melted at about 2270°C forming β-MoB phase which melted without decomposition at about 2550°C. It is believed that carbon content increases the stability of carbon borides and widens the region of their homogeneity. It is felt that some of the results did not agree with those of previous experiments for this reason. (ATD)

4809 INVESTIGATION OF THE SYSTEM W-Ta-Re BY THE DIFFUSION-LAYER METHOD. Tregubov, I. A.; Kuzina, L. N.; Batyrev, V. A.; Kuznetsova, S. M.; Ivanov, O. S.; Borovskii, I. B. Izv. Akad. Nauk SSSR, Metal., No. 4, 191-9(July-Aug. 1967). (In Russian).

The phase fields of the constitution diagrams of the systems W-Ta, W-Re, Ta-Re, and W-Ta-Re at 2500°C were investigated by local x-ray spectral analysis of diffusion layers (measurement of the change in the concentration of the constituents in the diffusion layer). In the system W-Ta the concentration curves in the diffusion layer display a monotone course corresponding to unlimited solubility of Ta and W. In the system W-Re the boundaries of W-base solid solution were found to lie at 33 wt % Re and of Re-base solid solutions, at 14 wt % W, and the region of existence of the δ-phase was located at 46 to 72 wt % Re. Two-phase regions are, as a rule, absent in this system. In the system Ta-Re the boundary of Re-base solid solutions was found to be 3 wt % Ta and of Ta-base solid solutions, at 54 wt % Re. The regions of existence of δ- and χ-phases range from 54 to 57 wt % Re and from 64 to 87 wt % Re, respectively. In the Ta-Re diffusion layer the δ-phase can be distinctly observed. In the case of the ternary

W–Ta–Re region the diffusion layer method made it possible to determine not only the range of existence of one- and two-phase regions along the 2500°C isothermal section of the constitution diagram of the ternary system but also to determine the direction of tie lines in the two-phase regions. Owing to the difference in the diffusion mobilities and directions of the tie lines, the composition of the diffusion layer deviates from the line linking the compositions of the diffusion pairs. (ATD)

4810 SOLUBILITY OF LANTHANUM IN SILVER. Pravoverov, N. L.; Belyaeva, V. I. Izv. Akad. Nauk SSSR, Metal., No. 4, 199-201(July-Aug. 1967). (In Russian).

To test the theory that lanthanum does not dissolve in silver, Ag–La alloys containing from 0.05 to 5 wt % La were investigated by microstructural analysis. Electrical resistance and microhardness measurements were made. In annealed and quenched states a single-phase structure is displayed by only the alloy containing 0.05% La, while the other alloys display a two-phase structure. On quenching from 710°C the structure of the alloy containing 0.1% La becomes more complex, displaying some striation of grains. The structures of the alloys containing ≥0.2% La display eutectic inclusions. Following quenching from 750°C no second phase was detected in the alloys with 0.05 and 0.1% La, but it was detected in the alloy with 0.2% La. Thus, microstructural analysis shows that some solubility of La in silver occurs in the Ag–La system. This is confirmed by the sharp increase in steepness and inflection of the curves of microhardness and resistivity in the region of concentrations of 0.1 to 0.15% La. Thus methods of physicochemical analysis indicate that La is soluble in Ag to about 0.05 wt % at room temperature; within the limits of 0.05 to 0.1 wt % at 710°C; and within the limits of 0.1 to 0.2 wt % at 750°C. (ATD)

Radiation Effects

Refer also to abstracts 4316, 4320, 4377, and 5925.

4811 (AD–646662) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, August 1–October 31, 1966. Steele, L. E.; Hawthorne, J. R.; Serpan, C. Z.; Gray, R. A. (Naval Research Lab., Washington, D. C.). Nov. 15, 1966. 30p. (NRL-MR-1731). CFSTI.

Information is presented on the comparative response of A302-B and several higher strength steels after irradiation at 200°F and at 550°F. A comparative evaluation of the notch ductility of 3½% Ni–Cr–Mo weld and base plate after irradiation at 200 and at 550°F is included along with information on the notch ductility characteristics of irradiated AISI 304L and 347 stainless steels. The response of A350-LF1 (Modified) steel to cyclic irradiation and annealing treatment, and the through-thickness embrittlement and neutron flux variations in a simulated wall of a reactor pressure vessel are also examined. (auth)

4812 (ORNL–4195) RADIATION METALLURGY SECTION, SOLID STATE DIVISION PROGRESS REPORT FOR PERIOD ENDING JULY 1967. (Oak Ridge National Lab., Tenn.). Nov. 1967. Contract W-7405-eng-26. 63p. Dep. CFSTI.

The radiation embrittlement of weld heat-affected-zone (HAZ) samples and base-plate samples of ASTM A-212B pressure vessel steel is being investigated as a function of radiation dose and temperature. The increase in ductile-brittle transition temperature is sharply reduced for irradiation temperatures above 300°C. Preliminary results indicate no systematic differences in dependence on irradiation temperature for HAZ samples as compared with base-plate samples. Samples shielded with cadmium exhibited the same degree of embrittlement as unshielded ones, thus suggesting that the embrittlement is relatively insensitive to thermal neutrons. Quantitative measurements of the relative amounts of shear and cleavage fracture appearance were made; the fracture appearance indicates a narrower transition from ductile to brittle behavior than the fracture energy, but the two properties are in essential agreement. Tensile tests, electrical resistivity measurements, and internal friction measurements were conducted on unirradiated and irradiated vacuum-melted Fe with and without the addition of 20 wt ppM of N. Annealing experiments following irradiation at –50 to –95°C showed an annealing stage at 35°C in the Fe – 20 wt ppM N material that is not present for the N-free Fe. This is attributed to the trapping of N at radiation-produced defects. The tensile samples indicated an increase in yield stress upon irradiation, followed by a further increase upon annealing in the range –35 to 100°C. However, this was observed for samples of both N contents. Defect clusters and dislocation channeling were observed in neutron-irradiated Nb for the first time; a dose of 2×10^{18} neutrons/cm^2 (E > 1 MeV) produced a spot density of approximately 5×10^{15} per cm^3. The spot size distribution showed a peak at a spot diameter of about 80 Å. As a result of resistivity and internal friction measurements, the post-irradiation annealing stage in Nb at 150°C ("Stage III" annealing) was shown to be due to the motion of O to radiation-produced defects. The activation energy was 1.19 eV. No Stage III annealing was observed after cold work for a low-O Nb sample. Temperature dependence of the yield stress in single-crystal Nb was virtually unchanged by neutron irradiation, in agreement with previous results from Fe indicating that the mechanism for the thermal activation of flow is not affected by the radiation-produced defects. A mechanism of radiation hardening in bcc metals by contact interaction between dislocations and damage clusters is formulated and is compared with the experimental results on irradiated Nb. The stress dependence of dislocation velocity was measured directly by etching techniques for unirradiated Nb as a function of temperature and number of zone passes and for irradiated single-zone-pass Nb at room temperature. The equation $\bar{v} = (\tau/\tau_0)^{m*}$ was obeyed. For decreasing test temperatures in the range 300°K to 77°K, m* is not greatly changed and τ_0 is greatly increased. Preliminary results at room temperature indicate a decrease in m* and an increase in τ_0 upon irradiation. Indirect measurements of m* by change-in-strain-rate tests and stress-relaxation tests did not agree with m* determined by the etching technique. (auth)

4813 (TID-24148) GTR-16 RADIATION EFFECTS TEST ON STRUCTURAL MATERIALS AT -423°F. FINAL REPORT. NERVA PROGRAM. Weleff, W.; Dixon, C.; Bauer, J.; Dessau, P.; Matt, R. (Aerojet-General Corp., Sacramento, Calif.). Nov. 1966. Contract SNP-1. 197p. (RN-S-0290). Dep. CFSTI.

Results are reported of the second radiation test on structural materials conducted for the NERVA Program. Detailed data pertaining to structural materials; ultimate and yield tensile strength, reduction of area, elongation, stress-strain curves, notched tensile strength, notched-to-unnotched strength ratio, and shear strength are included. Micrographs of representative specimens of each material in strained and unstrained region, as well as x-ray diffraction and electron fractographs are included. Radiation effects were evaluated by comparing the mechanical and metallurgical properties with and without radiation. All materials used were alloys and were irradiated and tested at liquid hydrogen environment without warm up. The average dose level obtained was 5×10^{16} nvt (E > 1.0 MeV). Control and irradiated data for three types of bearing retainers are given. These retainers were made of Armalon containing FEP Teflon, or TFE Teflon. The irradiated specimens received a maximum integrated fast neutron exposure of $6 > 10^{16}$ nvt (E > 1.0 MeV) and 1×10^{11} ergs/g(C) while immersed in LH_2. Both control and irradiated specimens were tested at room temperature. (auth)

4814 ELECTRON MICROSCOPY STUDY OF DEFECT-CLUSTER AGGLOMERATES IN ION-IRRADIATED COPPER FOILS. I. ANALYSIS OF AGGLOMERATE TYPE AND CONFIGURATION. Diepers, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Phys. Status Solidi, 24: 235-44(Nov. 1, 1967). (In German).

Epitaxially grown copper foils are irradiated with monoenergetic Ar ions (5 keV). Defect clusters, produced by this irradiation, are visible in the electron microscope as small black spots which are not completely resolvable. The depth position of the defects in the foil is determined by stereo microscopy. This method, developed for this purpose, is described. After finding the depth position of the clusters the dynamical theory of contrast (Rühle et al.) is used to determine the defect type (i.e. vacancy or interstitial clusters) and the cluster configuration. The agglomerates consist of interstitial atoms and predominantly have the configuration of Frank dislocation loops. All of agglomerates are located in a small depth zone below the irradiated surface. (auth)

4815 RESISTIVITY STUDIES OF ELECTRON-IRRADIATED IRON. Neely, H. H.; Keefer, D. W. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. Phys. Status Solidi, 24: 217-20(Nov. 1, 1967).

Isochronal annealing studies of 1.3-MeV electron-irradiated iron have been performed. Results indicate that long range interstitial migration occurs in resistivity annealing substage I_E (120 to 150°K). (auth)

4816 EVIDENCE FOR TRAPPING OF BUBBLES BY ALUMINA PARTICLES IN α-BOMBARDED Al – Al_2O_3 ALLOYS. Rudel, E. (EURATOM, Ispra, Italy). Mater. Res. Bull., 2: 369-74 (Mar. 1967).

It has been suggested that the swelling of nuclear fuels might be reduced by the presence of a dispersion of second phase particles in the fuels. The particles, by trapping fission gas bubbles formed and migrating in the fuel matrix, would keep the bubbles small and finely dispersed. Direct evidence was sought by transmission electron microscopy for trapping of bubbles by Al_2O_3 particles. Prethinned Al foils containing a dispersion of 2.5% Al_2O_3 were bombarded with α particles at room temperature and were

subsequently examined by transmission electron microscopy. In the Al matrix of the α-bombarded foils, heavy damage in the form of a dense dislocation tangle was observed. The tangle was preserved even after annealing at 620°C for 1/2 hr while numerous small bubbles along the tangle were formed. Only after annealing at ~650°C was the number of dislocations markedly reduced, and a simultaneous growth of the bubbles had occurred. In the areas of narrow interparticle spacing the bubbles were efficiently trapped by Al_2O_3 particles. (BBB)

4817 RELATION OF ORIENTATION TO INCREASED RESISTANCE PRODUCED BY α IRRADIATION. Haager, M.; Siebinger, K. (Univ., Vienna). Berg- Huettenmaenn. Monatsh. Montan. Hochsch. Leoben, 111: 112-16(Mar. 1966). (In German).

Changes in resistance R as a function of orientation in thin samples of Zn metal of ~130-μm dia were measured by x ray following exposure to a 250-mCi ^{210}Po source. If a linear shaped crystal is α irradiated the exposed and nonirradiated crystal volumes act like parallel coupled resistances. The ideal case is where the dia is the same as the range of the α particle used. Crystals with almost parallel hexagonal and crystal axes, and crystals where these axes differed by ~90° were studied. Typical curves for the increase in resistance of equally thick crystals with extreme orientations are shown graphically for irradiation exposures of up to 80 hr. Resistance of crystals whose long axis was almost parallel to the hexagonal axis increased more than resistance in crystals with linear axis almost in the base plane. On the average, after 75 hr irradiation time for an angle of 8° Δ R/R was 0.58%, and where the angle was 88° Δ R/R was 0.38%. A saturation value was reached in the latter crystals, but the increase was more linear where the angle was less. For Al crystals 42-μm thick, 9-mm long, and 2-mm wide, where 38% of the test volume was exposed to the α irradiation, similar results were found. For the [100] and [110] poles, Δ R/R was 0.23%, and for the [111] pole Δ R/R was 0.18% after 75-hr irradiation. There was considerable anisotropy. The effects of focusing factors, orientation of the energy, and channeled atoms are discussed. (BBB)

4818 PHYSICAL CHARACTERIZATION OF MOLYBDENUM SINGLE CRYSTALS FOR IRRADIATION EXPERIMENTS. Kissinger, H. E.; Brimhall, J. L.; Mastel, B. (Battelle Memorial Inst., Richland, Wash.). Mater. Res. Bull., 2: 437-48(Apr. 1967).

Techniques used for the pre- and postirradiation characterization of irradiation damage in Mo single crystals are described, as well as effects of high-energy neutron bombardment on a nearly-perfect crystal. Preirradiation characterization was concerned with evaluating the degree of crystalline perfection of the sample crystals, whereas post-irradiation measurements provided quantitative information about the types and numbers of irradiation-induced defects and the extent to which these defects and other defects interact with each other. Highly perfect single crystals were prepared by repeated zone refining and subsequent annealing. Crystalline perfection was characterized by x-ray diffraction topography, integrated diffracted intensity, precision lattice parameter, x-ray profile, and electron microscopy. These measurements were repeated after exposure to high-energy neutrons, and were supplemented by precision measurements of dimensional changes. The observed changes in these properties were explained in terms of irradiation-induced point defects. During irradiation at 40°C, interstitial defects migrated and formed stable clusters which grew in size with increasing exposure. Vacancies were less mobile, and persisted as isolated defects or very small clusters. (BBB)

4819 ON THE STAGE-III RECOVERY OF ELECTRON-IRRADIATED ALUMINIUM. Brugiere, R.; Lucasson, P. (Faculte des Sciences de Paris, Orsay, France). Phys. Status Solidi, 24: K77-81(Nov. 1, 1967).

Pure Al was irradiated at −130°C with either 1.0- or 1.5-MeV electrons, and the irradiated samples were then annealed isochronally or isothermally. The results show two III substages with activation energies of 0.32 and 0.58 eV, in agreement with Budin and Lucasson. It is concluded that the same point defect is migrating in the stages III and H_2. (D.L.C.)

4820 ORIENTATION SUBSTRUCTURE CREATED BY ELECTRON IRRADIATION UNDER MAGNETIC FIELD IN Ni–Co ALLOYS WITH 50 and 75 PERCENT Ni. Chamton, William (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. A and B, 265: 342-5(Aug. 1967). (In French).

Ni–Co alloys treated under magnetic field either by irradiation in the hot state or by anneal after irradiation at low temperature have a uniaxial magnetic anisotropy which is interpreted by the theory of orientation superstructures. The mechanism by which the diffusion is activated by irradiation is particularly complex. (tr-auth)

4821 INFLUENCE OF ELEVATED-TEMPERATURE IRRADIATIONS ON THE CREEP-RUPTURE PROPERTIES OF POLYCRYSTALLINE MOLYBDENUM. Moteff, J.; Kingsbury, F. D. (General Electric Co., Cincinnati). Trans. Amer. Nucl. Soc., 10: 428(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4822 EXAMINATION OF IRRADIATED CVTR ZIRCALOY PRESSURE TUBE. Smalley, W. R. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 470(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4823 NEUTRON IRRADIATION EFFECTS IN ZIRCALOY FUEL CLADDING. Aqua, E. N.; McClintock, D. R. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 469-70(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4824 SHORT-TERM IRRADIATION TESTING OF HEAVILY HYDRIDED ZIRCALOY-2 FUEL SPECIMENS. Rowland, T. C. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 10: 468-9(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4825 COMBINED EFFECTS OF HYDROGEN AND IRRADIATION AT 650 AND 775°F ON TENSILE PROPERTIES OF ZIRCALOY-4. Harbinson, E. N.; Baroch, C. J. (Babcock and Wilcox Co., Lynchburg, Va.). Trans. Amer. Nucl. Soc., 10: 467-8(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4826 POSTIRRADIATION THERMAL PROPERTIES OF A URANIUM-FISSIUM ALLOY AS A FUNCTION OF BURNUP. di Novi, R. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 476-7(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4827 RADIATION GROWTH AND SWELLING ANALYSIS OF SOLID CYLINDRICAL FUEL ELEMENTS FOR A COMPLETE REACTOR PERIOD. Ma, Benjamin M. (Iowa State Univ., Ames). Trans. Amer. Nucl. Soc., 10: 512-13(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4828 CREEP MEASUREMENT DURING NEUTRON IRRADIATION. Gilbert, E. R.; Harding, N. E.; Hood, G. L. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 503-4(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4829 POSTIRRADIATION EXAMINATION OF FAILED HFIR TARGET ELEMENTS. Manthos, E. J.; Adams, R. E.; King, R. T.; Long, E. L. Jr.; Van Cleve, J. E. Jr.; Lotts, A. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 480-1(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4830 SUPERIOR IRRADIATION PERFORMANCE OF STAINLESS-STEEL CERMET FUEL PLATES THROUGH USE OF LOW-DENSITY UO_2. Graber, M. J.; Zukor, M.; Gibson, G. W. (Idaho Nuclear Corp., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 10: 482-3(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4831 DEVELOPMENT AND TESTING OF HIGH-LOADED UO_2–Cb CERMET FUEL. Fuhrman, N.; Holden, R. B. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 10: 483-4(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4832 HIGH-TEMPERATURE DUCTILITY OF 300 SERIES STEELS AND INCOLOY-800 AFTER IRRADIATION IN EBR-II TO 2 x 10^{22} n/cm^2. Comprelli, F. A.; Withop, A.; Weinstein, D. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 10: 487(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4833 EFFECT OF FAST-REACTOR IRRADIATION ON THE TENSILE PROPERTIES OF TYPE-304 STAINLESS STEEL. Holmes, J. J.; Irvin, J. E. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 487-8(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4834 POSTIRRADIATION TENSILE PROPERTIES OF ANNEALED AND COLD-WORKED AISI-304 STAINLESS STEEL. Robbins, R. E.; Holmes, J. J.; Irvin, J. E. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 488-9(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4835 THE EFFECTS OF NEUTRON IRRADIATION ON THE TENSILE PROPERTIES OF ANNEALED TYPE-410 STAINLESS STEEL. Lovell, A. J.; Robbins, R. E. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 489-90(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4836 THE EFFECT OF HELIUM GAS BUBBLES ON THE CREEP DUCTILITY OF A NEUTRON-IRRADIATED AUSTENITIC ALLOY. Woodford, D. A. (General Electric Co., Schenectady, N. Y.); Smith, J. P.; Moteff, J. Trans. Amer. Nucl. Soc., 10: 490-1(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4837 THE EFFECT OF NEUTRON IRRADIATION AT 550°F ON THE MECHANICAL PROPERTIES OF Ni–Cr–Fe ALLOY-600 WROUGHT AND WELD METAL AND TYPE-347 STAINLESS STEEL. Powers, A. E.; Baldwin, E. E. (Knolls Atomic Power Lab., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 10: 491-2 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4838 THERMODYNAMICS OF FISSION-PRODUCT SODIUM SOLUTIONS. Castleman, A. W. Jr.; Tang, I. N. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 494-5(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4839 DIRECT OBSERVATION OF NEUTRON IRRADIATION DAMAGE IN NIOBIUM. Tucker, R. P.; Ohr, S. M. (Oak Ridge National Lab., Tenn.). Phil. Mag., 16: 643-6(Sept. 1967).

Polycrystalline sheets of pure niobium were irradiated to a dose of 2×10^{18} neutrons/cm^2 (E > 1 MeV). Defects appearing as black spots, as well as black–white contrasts, were observed by transmission electron microscopy. The density of the black spots was estimated as 5×10^{15}/cm^3. The defects were identified as small dislocation loops. Slip traces free of black spots were observed after plastic deformation. Attempts are being made to determine the nature of the loops. (auth)

4840 DIRECT ELECTRON MICROSCOPIC OBSERVATION OF THE ORIGIN OF RADIATION DAMAGE IN METALS. Martin, I.; Schulze, K. -J. (Battelle-Institut e. V., Frankfurt am Main). Naturwissenschaften, 54: 439(Aug. 1967). (In German).

Polycrystalline foils of 18/8 chrome–Ni steel were subjected to α irradiation during electron microscopic observation. After an hour's radiation, sharply limited dark regions were observed in the foil. These regions were not arranged homogeneously. The areas were round and their number increased with increasing radiation dose up to a saturation degree of approximately 2,000 spots μM^{-2} after 22 hrs of irradiation. Diffraction studies indicated supplementary Debye-Scherrer rings which were assigned to a new very fine crystalline phase. The evaluations of the diffraction rings are tabulated. (J.S.R.)

4841 DIRECT RADIATION EFFECTS ON THERMOCOUPLES. Leonard, James H.; Hunkar, Denes B. (Univ. of Cincinnati). Nucl. Appl., 3: 718-27(Dec. 1967).

Sheathed Chromel/Alumel and iron/Constantan thermocouples of various geometries were exposed to varying radiation levels from a nuclear reactor while immersed in a constant-temperature medium. Emf measurements indicated transient changes in thermocouple calibration of as much as 18°F occurring over periods of several hours after a change in radiation level. After further exposure (1×10^{18} n/cm^2 for fast neutrons), the magnitude of the transient decalibration effect had diminished. This behavior is consistent with a mechanism involving changes in electron mobility in the two thermoelectric materials due to the appearance of radiation-produced scattering centers followed by self-annealing. (auth)

4842 STUDY OF IRRADIATION EFFECTS ON OXIDATION OF STAINLESS STEELS. Bennett, M. J.; Humphries, P. W. E.; Williams, D. E. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Eng., 12: 758-63(Oct. 1967).

Experimental equipment and techniques are described for studies of the effects of irradiation on the gaseous oxidation of stainless steels at temperatures in the range 600 to 850°C. The effects of a fission neutron flux of 6×10^{13} n/cm^2/sec in flowing CO_2 were studied in a hollow fuel element rig contained in a Zircaloy thimble (2 in. ID) in the PLUTO materials testing reactor. For the study of the effects of fission fragments, fluxes of 6×10^8 ff/cm^2/sec were generated by irradiation of UO_2 pellets or a thin U_3O_8 layer in the graphite reactor BEPO. The rig, contained in a vertical aluminum thimble (3.75 in. OD), provided for irradiation in static CO_2 and O_2. (UK)

4843 WEAKENING EFFECT OF NEUTRON IRRADIATION ON CAST IRON. Markovskii, E. A.; Krasnoshchekov, M. M. Russ. Cast. Prod. (Engl. Transl.), No. 6, 273-4(June 1966).

A study of the effect of neutron radiation on the antifriction properties of structural materials shows that such radiation under ordinary nuclear reactor conditions, without special cooling and subjected to gamma-radiation, can lead to a softening in the material. This is observed in annealed malleable iron. Specimens of malleable iron, annealed 34 hr at 970°C, are radiated on a VVR reactor with integral flows 10^{16}, 10^{17}, 10^{18}, 10^{19} and 10^{20} neutrons/cm^2. Specimens are tested both before and after radiation to determine linear wear, friction coefficient, temperature of lubricant emitting from friction zone, hardness, and microstructure. Microstructure, friction coefficient and lubricant temperature do not change during the radiation process. However, the degree of wear is substantially affected in iron irradiated at an integral flow of 10^{18} neutron/cm^2; the degree of wear rises at first and then, after further radiation, decreases. Hardness decreases with even slight radiation, then increases. (Rev. Met. Lit.)

4844 VOIDS IN IRRADIATED STAINLESS STEEL. Cawthorne, C.; Fulton, E. J. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Nature (London), 216: 575-6 (Nov. 11, 1967).

Electron microscope studies are described on samples of stainless steel (AISI type 316) irradiated in the Dounreay Fast Reactor, employing the thin foil technique. A common feature of all specimens examined after irradiation to >10^{22} n/cm^2 in the temperature range 400 to 610°C was the presence of spherical or polyhedral cavities varying in size up to 1500 Å. This void population was too great to be accounted for solely by helium formation. The voids are considered to develop through the condensation of irradiation produced vacancies on helium nuclei. This is supported by the behavior of the voids on annealing. Specimens containing voids of average diameter 210 Å, and occupying 1.5% of the total volume, were annealed for 1 hr at 700 and 900°C. While the lower temperature treatment left the voids relatively unchanged, the 900°C treatment almost completely removed them, leaving a residue of porosity, confined mostly to grain boundaries, which could reasonably be equated with helium content. Experiments were also made in which a fuel pin was used to investigate the effect of irradiation temperature (270 to 560°C) on void population. Voids were observed only in the hottest specimens, the average void size increasing with irradiation temperature, and the total void volume peaking at 510°C. The maximum void volume observed in any specimen examined was 7%, with an average void diameter of 1100 Å; this occurred in a fuel pin at a point where the irradiation temperature was 500°C and the total neutron dose was 7.8×10^{22} n/cm^2. It is pointed out that although cladding stresses may influence the subsequent enlargement of voids, they are not an essential prerequisite for void formation. (UK)

4845 STUDY OF LITHIUM MOBILITY IN IRRADIATED SILICON. Hackler, Walter Anthony. Ann Arbor, Mich., Univ. of Michigan, 1966. 98p.

Thesis.

The effect of fast neutron and electron induced defects on the diffusion properties of lithium in silicon was determined. The effect was determined by irradiating lithium diffused diodes and subsequently applying a reverse bias to the junction at a constant temperature. Experimental results show that fast neutron and 0.9 MeV electron induced vacancies provide sites for the precipitation of lithium. Moreover, the lithium vacancy precipitate behaves like a solute in equilibrium with ions and ionized vacancies. The analysis of the lithium vacancy precipitate in this fashion is

analogous to the analysis of slightly soluble salts in water. The lithium diffusion coefficient for silicon exposed to fast neutrons, $N_N = 1.1$ to 2.7×10^{14} n/cm², can be expressed as $D = (7.0 \times 10^{12}/N_N)\, e^{-0.83/kT}$ cm²/sec. The range of (T) in the above expression is from 300 to 410°K. It also was shown that the motion of lithium in silicon was not affected by slow neutron irradiation. In addition, the lithium diffusion coefficient for silicon exposed to 0.9 MeV electrons, $N_E = 5 \times 10^{15}$ to 3.3×10^{16} e/cm², can be represented by $D = (2.1 \times 10^{18}/N_E)\, e^{-1.03/kT}$ cm²/sec. The range of T in the above expression is from 300 to 330°K. Relative radiation damage between neutrons and electrons was found to be in reasonable agreement with predictions based on radiation damage theory. (Disser. Abstr.)

4846 PROTON RADIATION INDUCED BLISTERING OF ALUMINUM. Milacek, Leonard. Norman, Okla., Univ. of Oklahoma, 1967. 95p.

Thesis.

Investigation of the effects of low energy proton irradiation of aluminum and gold samples demonstrated that protons in the energy range 7 to 450 keV could cause permanent damage to the materials. This damage is in the form of pitting and blistering of the metal surface. These observations are of significance to the application of these materials for thermal control surfaces in space flight applications. High purity aluminum exhibited surface pitting and blistering in the irradiated area. Pitting occurred during irradiation and is the predominant surface damage at lower proton energies. Blistering occurs spontaneously at room temperature for samples irradiated at energies of 70 keV or lower. Samples irradiated at energies of 100 keV or higher may exhibit a small amount of spontaneous blistering, but annealing above 200°C is necessary to produce large concentrations of blisters. The proton radiation induced pitting and blistering phenomena were studied using optical and electron microscopy. Attention was given to determine the influence of crystal orientation, surface preparation, material purity, substructure, and cold work on the manner of occurrence and appearance of blistering. These observations were correlated with radiation and environmental parameters to delineate the processes responsible for pitting and blistering. Blistering is attributed to the trapping of protons and their agglomeration as hydrogen within voids in the lattice near the metal surface. Hydrogen pressure within these voids causes an expansion which is observed as blisters on the metal surface. Pitting was shown to be associated with exfoliation of the oxide on aluminum, and pits could be removed by oxide stripping. Pitting is explained by agglomeration of hydrogen at the oxide-metal interface with subsequent rupture and exfoliation of the oxide. The dependence of the effects observed upon metal purity and microstructure are consistent with the model for hydrogen agglomeration proposed. Definite correlations of pitting and blistering with crystal orientation were also demonstrated. The theoretical implications of these results are discussed. (Disser. Abstr.)

Ceramics and Cermets

Refer also to abstracts 4728, 4731, 6058, and 6138.

4847 SIGNIFICANCE OF CHARCOAL IGNITION TEMPERATURES. Davis, R. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 511-12(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

4848 THERMODYNAMICS OF CERAMIC SYSTEMS. Proceedings of the British Ceramic Society, London, Apr. 19-21, 1966. Proc. Brit. Ceramic Soc., No. 8, 1-257(June 1967). (CONF-660459).

Nineteen papers presented at the meeting are included. Separate abstracts were prepared for 11 papers. Two papers were previously abstracted for NSA. Topics covered in the other papers include: application of solution calorimetry to oxide systems, disorder in ferrites, stabilities of oxide compounds, thermodynamic relationships in partially liquid oxide systems, the Ti-C-N system, and oxidation-reduction equilibria of dilute magnesiowerestites. For abstract numbers of previously abstracted papers see CONF-660459 in the Report Number Index. (M.C.G.)

For abstracts of individual papers see: 4114-4119, 4881-4883, 4896, and 4897.

Corrosion and Erosion

Refer also to abstract 4081.

4849 A METHOD OF TREATING GRAPHITE ARTICLES AND PRODUCTS OBTAINED THEREBY. Besson, Michel; Elston, Jean; Morize, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,089,785. Nov. 8, 1967. Priority date June 9, 1965, France.

A method is described for treating graphite articles with a silicon carbide coating for corrosion protection in an oxidizing atmosphere such as is found in power reactors. The graphite article is placed in an atmosphere consisting of a mixture of hydrocarbon, silicon halide, and hydrogen. At 1100°C silicon halide is decomposed on contact with the graphite forming a silicon carbide deposit in the pores and on the surface of the graphite. (F.S.)

Preparation and Fabrication

Refer also to abstracts 4151 and 6040.

4850 (RT/ING-(67)6) THE PRESSING OF "AS RECEIVED" URANIUM DIOXIDE POWDERS. Giaquinto, L.; Majani, C.; Stamenkovic, I. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 22p. Dep.

The pressure-density dependence for fragile powders was evaluated by a mathematical approach based upon Kawakita empirical relationship. The cold pressing of a number of various uranium dioxide powders was performed at 0.5 to 6.5 ton/cm². The pressing results were treated by means of several empirical equations without sufficient success. A new interpretation of the pressing mechanism was proposed for fragile powders. The very close relation between green pellet characteristics and sintering kinetics was experimentally demonstrated. Qualitative interdependence of density of sintered powders and surface area of the initial green pellets has been pointed out. (auth)

4851 (UCRL-17826) EFFECT OF THE MICROSTRUCTURE ON THE SUPERCONDUCTIVE PROPERTIES OF Nb_3Sn IN A NbC MATRIX. Chabanne, Jean (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1967. Contract W-7405-eng-48. 34p. Dep. CFSTI.

Thesis.

Methods of hot-press processing of powder of Nb, Sn, C starting with various compositions have been investigated. The sintered product consists of grains of NbC surrounded by Nb_3Sn. Critical temperature measurements, x-ray diffraction, microprobe investigations, and critical field (H_{c2}) measurements in a pulsed field at 4.2°K have been made. A critical field of 240 kG at 4.2°K (J perpendicular to H) has been obtained by extrapolation for one of the samples. The current density was still 5000 A/cm² at 203 kG. Previous ways of manufacturing Nb_3Sn are described along with objectives of present efforts. Fabrication methods are discussed and descriptions are included on the variation of structure versus composition and versus heat treatment. The T_c results are presented and correlated to the heat treatment. (J.R.D.)

4852 (UJV-1356) SOME PROPERTIES OF THE CERMET UC-U. Jakes, D.; Voboril, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Aug. 1967. 5p. Dep.

A UC-U cermet containing 50 mole % UC was prepared from powdered metallic U and carbon black by sintering under A at 1150°C for 2 hr. It was determined by x-ray analysis and metallographic examination that penetration of U between the spheroidal carbide particles was close to the conditions of full wetting. The mean particle size of the UC was found to be dependent on the sintering temperature. (P.G.C.)

4853 (BNL-tr-158) ACCELERATOR TUBE ASSEMBLY TECHNOLOGY: VINYL ACETATE METAL-CERAMIC BONDING PROCESS. Bernard, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Brookhaven National Lab., Upton, N. Y., from report SEFS-TD-66/56. 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Metal-ceramic tubes for high-energy particle accelerators are joined by thermoplastic vinyl acetate. The method minimizes stresses in the ceramic, the assembly suffers no alteration with time, and the mechanical properties of the binding agent are unaffected by ionizing radiation. Techniques of assembly are described including composition and physical characteristics of the bonding agent, preparation of the parts for bonding, the bonding operation, drying, and heat treatment. (P.G.C.)

4854 PREPARATION AND INVESTIGATION OF BORIDE COATINGS ON MOLYBDENUM. Karev, V. N.; Klyucharev, A. P., Lishenko, L. G., Nazarova, T. S.; Rozen, A. A. (Inst. of Physics and Technology, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1676-8(Sept. 1967). (In Russian).

The coating of molybdenum with boride by means of the thermal dissociation of boron iodide on heated Mo surfaces in a vacuum was investigated at 1200 to 1600°K. Coatings that adhered well were obtained at 1470 to 1600°K. (J.S.R.)

4855 TRANSPARENT YTTRIUM OXIDE CERAMICS. Lefever, R. A.; Matsko, John (Sandia Lab., Albuquerque, N. Mex.). Mater. Res. Bull., 2: 865-9(Sept. 1967).

Preparation of transparent discs of yttrium oxide by vacuum hot forging at 950°C and 10,000 to 12,000 psi is described. The Y_2O_3 powder (average particle size ~3μ) was milled with 325-mesh lithium fluoride (3 to 5 wt %) for 12 hr in a plastic container, using alumina milling cylinders to break up agglomerates and acetone as the milling vehicle. The powder was dried and cold pressed at 3000 psi. A device, which is diagrammed, was used for vacuum press forging. The cold pressed compact was loaded into a mullite tube die and embedded in a zirconia setting. The system was evacuated to about 0.05 Torr and a pressure of 500 psi was placed on the compact as power was applied to the furnace. At 540°C, pressure on the compact was increased to 1200 psi, and at 850 to 900°C, pressure was increased to 2000 psi, at which point the forging action began. Temperature was increased to 950°C at 2000 psi, then pressure was increased (500 psi/min) until 10,000 to 12,000 psi was reached. This procedure produced 1-cm dia discs of yttrium oxide several millimeters in thickness. After grinding and polishing, optical transmission spectra were similar to those for single-crystal Y_2O_3. (BBB)

4856 DEVELOPMENTS IN THE ELIMINATION OF BORON LOSS DURING FABRICATION OF STAINLESS-STEEL-UO_2 CERMET FUEL. Pearson, C. V. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 481-2(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4857 THE BALL MILLING OF ALUMINUM POWDER FOR PRODUCTION OF ALUMINUM–Al_2O_3 DISPERSIONS. Copeland, G. L.; Martin, W. R. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 478(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4858 A STUDY OF PROCESSES FOR SAP POWDER CONSOLIDATION. Martin, M. M.; Martin, W. R. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 478-9(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4859 PREPARATION OF RARE-EARTH-OXIDE MICROSPHERES BY SOL-GEL PROCESS. Ambrose, C. J.; Andelin, R. L. Trans. Amer. Nucl. Soc., 10: 429-30(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4860 DENSITY CONTROL IN MIXED PuO_2–UO_2 FAST-REACTOR FUELS. Zambernard, M. J.; Seider, R.; Caldwell, C. S. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Trans. Amer. Nucl. Soc., 10: 457(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4861 EFFECTS OF THE CARBON CONTENT ON THE PROPERTIES OF WC–TiC–TaC–10 PERCENT Co ALLOYS. Suzuki, Hisashi; Hayaahi, Kozi; Kawakatsu, Ichiro (Tokyo Univ.). Nippon Kinzoku Gakkai, 31: 1100-6(1967). (In Japanese).

Investigations were made on properties of various WC–β_t–10% Co alloys (β_t = WC–TiC–TaC triple carbide phase having definite ratio of 70/30 in WC/TiC) affected by the carbon content, i.e., the binder phase composition. Specimens were vacuum-sintered at 1400°C for 1 hr. The amount of dissolved W in the γ-phase was considered to be the same as in WC–Co, WC–TaC–Co or WC–TiC–Co alloys; that is, it was in the range of 9 ~ 10% in maximum and 1 ~ 2% in minimum according to the carbon content. Ti and Ta hardly dissolved in the γ-phase. The maximum carbon content in the β_t-phase gradually approached the stoichiometric value with increasing tantalum carbide content, and the maximum carbon content reached the stoichiometric value at the content of more than 50 to 60% TaC. Hardness and strength of the alloys having the β_t-phase with 50 to 60% TaC were superior to those of the other alloys. The range of the (WC + β_t + γ) three-phase region and the mechanical properties of the alloys were mainly controlled by the titanium carbide content, but not by the tantalum carbide content in the alloys. Magnetic saturation, spe ific gravity, hardness, and lattice parameters of both γ and β_t phases showed a change with the carbon content in the alloys. (auth)

4862 INTERACTION EFFECTS BETWEEN THE CONSTITUENTS OF CARBON ARTEFACTS DURING GRAPHITISATION. Richards, B. P. (General Electric Co., Wembley, Eng.); Kellett, E. A.; Mason, I. B. J. Appl. Chem. (London), 17: 298-9(Oct. 1967).

A crystallographic study, using x-ray diffraction techniques, was made of the interaction effects between the constituents of coke-binder artefacts when heat-treated to graphitising temperatures. It is shown that petroleum and pitch cokes graphitise to a greater extent separately than when combined in petroleum coke/pitch binder artefacts, but for artefacts based entirely on either petroleum or pitch this effect of the binder in retarding graphitisation of the grist coke is very much less. (auth) (UK)

4863 PROCESS FOR THE PREPARATION OF THORIA SOLS. Fitch, Frederick Troop; Smith, Jean Gillen (to W. R. Grace and Co.). British Patent 1,090,547. Nov. 8, 1967. Priority date Nov. 2, 1964, United States.

A hydrothermal treatment method is described for the preparation of thoria sols containing dense, spherical particles in the size range from 10 to 650 mμ that are suitable for use as reactor fuels. Either a normal or basic salt of thorium with a monobasic acid may be used as a starting material. The aqueous solution of the salt is autoclaved at a temperature from 100 to 200°C for 2 to 30 hr. If the concentration of the thorium salt in the solution is greater than 2g of ThO_2/100 ml, it must be the basic salt of the acid. (B.L.M.)

4864 IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF GRAPHITE. Cornuault, Pierre; Bentolila, Jaques; Price, Michael Stuart Thomas (to United Kingdom Atomic Energy Authority). British Patent 1,090,232. Nov. 8, 1967. Filed July 22, 1963.

A process for making an extruded article of a fine grain carbonaceous material (graphite) having the majority of its open pores above 0.1 microns in dia is described. A calcined petroleum coke is ground and mixed with a pitch binder. The article is extruded and then baked. The article will have a high coefficient of thermal expansion which will rend it stable under irradiation at high temperature. (F.S.)

4865 IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF GRAPHITE. Bentolila, Jacques; Dubief, Leon; Price, Michael Stuart Thomas (to United Kingdom Atomic Energy Authority). British Patent 1,090,231. Nov. 8, 1967. Filed July 22, 1963.

A method is described for forming an extruded graphite from uncalcined or semicalcined coke by incorporating in the ground coke a special volatile organic binder such as pine resin which makes the particle sticky but not plastic. The binder is volatized or decomposed during baking. (F.S.)

Properties Evaluations

Refer also to abstracts 4099, 4114–4119, 4770, 5417, and 5418.

4866 (BNWL-SA-1494) THERMAL CONDUCTIVITY OF URANIUM OXYCARBIDES. Bates, J. Lambert (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 24, 1967. Contract AT(45-1)-1830. 25p. (CONF-671114-1). Dep. CFSTI.

From 7th Annual Conference on Thermal Conductivity, Washington, D. C.

The thermal diffusivity of uranium oxycarbide was measured at 100 to 1500°C as a function of oxygen concentration at 2 to 17 at. % of the anions. The thermal diffusivity (α) of the oxycarbides decreased and the shape of the α-versus-T curve changed as the oxygen content increased. Oxycarbides with the lowest oxygen content showed a decrease in α as the temperature increased, whereas the oxycarbides with the highest oxygen content exhibited a slight increase in α with an increase in temperature. The thermal diffusivities of all specimens, approach a common value near 0.05 cm^2/sec at the higher temperatures. The calculated thermal conductivities near 1500°C of the uranium oxycarbides are approximately 0.18 watts/cm-°C, very near the reported values for nearly stoichiometric and slightly hypostoichiometric UC. The thermal conductivities of the oxycarbides can be qualitatively separated into an electronic component, obeying the Wiedemann–Franz–Lorentz law, and a lattice component, varying inversely with temperature. The decrease in thermal conductivity at the lower temperatures with increasing oxygen content results primarily from changes in the lattice component. Small decreases also occur in the electronic component over the entire temperature range due to increases in oxygen content. (auth)

4867 (EUR-3644i) MISURA DELLA CONDUCIBILITA TERMICA DI MATERIALI DI INTERESSE NUCLEARE ENTRO 100^0 E 500^0C. (Measurement of the Thermal Conductivity of Materials for Nuclear Use Between 100^0 and 500^0C). Giuliani, S. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). June 20, 1967. 38p. (In Italian). Dep.

An apparatus has been devised for measurement of the thermal conductivity of solid materials at 100 to 500°C with an error of 6.5%. Results were obtained for UC, SAP, Magnox, Graphite, and impregnated graphite. In case of graphites measurements were performed before and after irradiation. (auth)

4868 (GEAP-5100G) HIGH PERFORMANCE UO_2 PROGRAM. IRRADIATION OF 0.5 INCH DIAMETER, SWAGED POWDER AND VIRBRATORY COMPACTED POWDER UO_2 FUEL RODS AT 600, 000 AND 800,000 Btu/h-ft^2 PEAK HEAT FLUX ASSEMBLY EPW 6/8A. Lyons, M. F.; Nelson, R. C.; Pashos, T. J.; Wilson, C. R.; Weidenbaum, B. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb. 1966. Contract AT(04-3)-189. 73p. (EURAEC-1935). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The fabrication data, irradiation history and the complete, correlated post-irradiation examination results are described for a four rod fuel assembly—designated EPW-6/8A—that was irradiated in the GETR-PWL. All of the fuel rods in this assembly were unsegmented, reactor-length rods clad in freestanding Zircaloy-2; two of the fuel rods were fabricated by vibratory compaction alone to a bulk density of 88 percent and the other two were fabricated by vibratory compaction followed by swaging to an average bulk density of 90 to 91 percent. The two swaged fuel rods had previously been irradiated as part of assembly EPW 6/8. Assembly EPW-6/8A was the second of a series irradiated to determine the feasibility and limitations in operating compacted powder UO_2 fuel rods with central melting. The second powder fuel assembly was preceded by the entire series of exploratory pellet fuel irradiations and by irradiation of one powder fuel rod assembly. The irradiations of the pellet fuel assemblies had shown that cladding swelling from UO_2 phase change volume expansion was the basic problem in operating with central melting. Further tests had demonstrated that the cladding swelling could be prevented by the provision of internal free volume—in the form of hollow pellets—to accommodate the UO_2 volume expansion. On this basis the somewhat lower density powder rods (90 to 91 percent TD compared with 92 to 93 percent effective bulk density for the solid pellet rods) were tentatively expected to be less subject to cladding swelling. Conversely, the first powder assembly—EPW-6/8—indicated that powder fuel rod swelling was greater than that with pellets at the same thermal performance. However, the confidence in the generality of the result was reduced by the unique swelling characteristics observed. The second power assembly irradiation—EPW-6/8A—confirmed the greater swelling with powder fuel but also demonstrated that cladding swelling could be significantly reduced by using lower initial density powder, i.e., 88 percent dense instead of 90 to 91 percent dense. Subsequent irradiation of a fuel assembly containing four 88 percent dense, vibratory compacted powder rods—assembly EPW-6/8V—for a complete GETR reactor cycle confirmed the EPW-6/8A results. (auth)

4869 (LA-3821) CMF-13 RESEARCH ON CARBON AND GRAPHITE. Report No. 3. Summary of Progress from August 1 to October 31, 1967. Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). Nov. 1967. Contract W-7405-eng-36. 24p. Dep. CFSTI.

An investigation of techniques for deagglomerating and preparing carbon black samples for electron micrography and particle counting is being made. Helium pycnometer densities were determined for 13 cokes, 8 graphite flours, 5 ground pyrolytic graphites and 1 carbon black. Surface area analyses were completed on 7 samples of YBF graphite. An attempt is being made to predict mixing ratios that will increase the densities of extruded graphite rods. Several resins were made by polymerization of furfuryl alcohol. Grinding studies are being carried out on graphite. Estimations of optimum binders concentration in graphite production are discussed. Effects of resin properties on the properties of resin-bonded graphites are described. Studies of the structure of solid raw materials, intermediate products, and manufactured carbons and graphites are reviewed. Effects of prior creep strain on the activation energy for tensile creep of graphite, compressive creeps of graphite, and creep of zinc are considered. Thermal expansion, thermal conductivity, and swivelling of graphite are discussed. (M.C.G.)

4870 (SC-RR-67-730) SWITCHING LIFE PERFORMANCE OF POLYCRYSTALLINE FERROELECTRICS. Plumlee, Ralph H. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1967. Contract AT(29-1)-789. 54p. Dep. CFSTI.

Exploratory switching-life measurements were made on various polycrystalline ferroelectric perovskite compositions. With 1 μsec square wave switching fields nominally equal to 3 times the slow loop coercive field, most of these materials survive 10^6 to 10^7 switching cycles. Even the poorest compositions tested are greatly superior to $BaTiO_3$ crystals for 1 μsec switching, both in viability and usable switching speed. One exceptional composition, recently developed by Clevite, readily survived 1.1×10^9 such switching cycles. In addition, this composition can be switched in about 10 nsec at 40 kv/cm, as fast as $BaTiO_3$ single crystals at 170 kv/cm. These exceptional properties are probably due to the coexistence or near coexistence of three crystal structures with nearly equivalent unit cell constants and free energies. This condition gives each unit cell a large number of nearly equivalent polar directions for re-alignment so that switching occurs at moderate fields largely on a unit cell basis rather than on a domain basis. This, in turn, minimizes the transient and net switching strain excursions and, hence, the mechanical fatigue responsible for the catastrophic failure of switched elements. (auth)

4871 (WAPD-TM-587) MECHANICAL PROPERTIES OF OXIDE FUELS (LSBR/LWB DEVELOPMENT PROGRAM). Wolfe, R. A.; Kaufman, S. F. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1967. Contract AT(11-1)-Gen-14. 132p. Dep. CFSTI.

The mechanical properties of unirradiated oxide fuel materials have been reviewed and an evaluation has been made of the effects of temperature, stress and material variables on the elastic, plastic, creep, hot pressing, and fracture strength properties. The materials discussed include UO_2, ThO_2, ThO_2-UO_2 and ZrO_2-UO_2 compositions. Experimental data were taken from a review of the literature. (auth)

4872 ELECTRICAL RESISTIVITY OF CUBIC RARE EARTH, THORIUM, AND URANIUM TUNGSTEN BRONZES. Ostertag, Werner (Air Force Materials Lab., Wright-Patterson AFB, Ohio); Collins, Charles V. Mater. Res. Bull., 2: 217-21 (Feb. 1967).

Tungsten bronzes are nonstoichiometric compounds, M_xWO_3, where M is some strongly electropositive element and x has some value between 0 and 1. Cubic or pseudocubic tungsten bronzes have been prepared for M = Li, Na, Cd, and rare earths including La, Th, and U. The element M, which occupies the interstices of the WO_3 framework, is generally assumed to be completely dissociated into cations and free electrons. The valence state of M in M_xWO_3 and the homogeneity range of the perovskite-type phases is given. On the basis of the lower limit of the homogeneity range and valence state exhibited by M, it was previously suggested that occurrence of the cubic phase of M_xWO_3 is controlled by the number of free electrons rather than by the number of M atoms inserted into the WO_3 framework. The concept implies metallic behavior for cubic W bronzes. Electrical measurements were performed on cubic rare earth, Th, and U tungsten bronzes to see how the electrical properties of these phases, having relatively small x values, compare with those of metallic Li_xWO_3 and Na_xWO_3. The electrical resistivity of single crystals of $Sm_{0.09}WO_3$, $Gd_{0.19}WO_3$ and powder specimens of $Gd_{0.085-0.19}WO_3$, $Th_{0.075}WO_3$, and $U_{0.09}WO_3$ was measured as a function of temperature at 150 to 400°K using a potential probe method. The resistance of all samples increased linearly over the entire temperature range. Measurements of the resistivity as a function of the x value of Gd_xWO_3 showed that the resistivity decreased with increasing x value. (BBB)

4873 GEOMETRY OF SOME REFRACTORY METAL DIOXIDES. Kaufman, M.; Muenter, J.; Klemperer, W. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 47: 3365-6(Nov. 1, 1967).

The deflection by an electrostatic quadrupole of molecular beams of SiO_2, TiO_2, ZrO_2, CeO_2, ThO_2, TaO_2, and UO_2 was measured. Of the above species only SiO_2 was found to be nonpolar while the remaining species were found polar. This sequence (with the exception of TaO_2 and UO_2) together with CO_2 forms an isoelectronic sequence with previously investigated alkaline-earth difluorides. In each instance the geometry of isoelectronic partners is similar. (auth)

4874 APPLICATION OF DIFFUSION IN AN ELECTRIC FIELD BETWEEN 900 AND 1100°C TO THE DETERMINATION OF THE COEFFICIENT OF DIFFUSION OF OXYGEN IN THE URANIUM OXIDE UO_2. Dornelas, Walter; Lacombe, Paul (Centre de Recherches Metallurgiques de l'Ecole des Mines, Paris). Compt. Rend., Ser. C, 265: 359-62(Aug. 7, 1967). (In French).

By diffusion in an electric field at 900 to 1,100°C in the uranium oxide, UO_2, the transport number of the anion was determined. This has made it possible, beginning with the Nernst-Einstein relation, to determine the diffusion coefficient of oxygen. Moreover, measurements of microhardness have permitted the determination of the oxygen concentration gradient created by the electrotransport. (tr-auth)

4875 HIGH-TEMPERATURE MATERIALS WITH SILICON NITRIDE AND ALUMINA AND MAGNESIA BASE. Kazakov,

V. K. (Inst. of Problems in Study of Materials, Kiev). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1661-7(Sept. 1967). (In Russian).

The technology for preparation of refractory materials from magnesium oxide and silicon nitride and from aluminum oxide and silicon nitride, with content of each component in the material from 20 to 80 mole % is described. The refractory materials of MgO–Si_3N_4 have the following properties: limit of the bending strength is 12 to 14 kg/mm², compression resistance is 30 to 35 kg/mm², weight increase during oxidation at 1200°C is 3 to 6 mg/cm², electric resistance at 20°C is 10^{10} to 10^{12} ohm-cm, the coefficient of thermal stability at 1500°C is 20 to 30 times the aqueous thermal exchange coefficient, and the stability is high with respect to interaction of borax–zinc melts. Refractory materials from Al_2O_3–Si_3N_4 have the following properties: limit of bending strength is 6 to 7 kg/mm², compression resistance is 16 to 18 kg/mm², weight gain during oxidation at 1200°C is 2 to 5 mg/cm², the electric resistance at 20°C is 10^9 to 10^{11} ohm-cm, and the thermal stability coefficient at 1500°C is 30 to 35 times the aqueous thermal exchange coefficient. (tr-auth)

4876 SOLUBILITY OF COPPER IN LIQUID SODIUM. Eichelberger, R. L.; McKisson, R. L. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 495-6 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4877 COMPATIBILITY OF SODIUM- AND HELIUM-BONDED URANIUM–PLUTONIUM CARBIDE FUELS WITH SEVERAL CLADDING MATERIALS. Powers, R. M.; Strasser, A. A. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 10: 471 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4878 THE EFFECTS OF STOICHIOMETRY ON THE THERMAL EXPANSION OF 20 WT PERCENT PuO_2–UO_2 FAST-REACTOR FUEL. Roth, J.; Hubert, M. E.; Cherry, J. R.; Caldwell, C. S. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Trans. Amer. Nucl. Soc., 10: 457-8 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4879 ELECTRICAL PROPERTIES OF THORIUM NITRIDES. Auskern, A. B.; Aronson, S. A. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem. Solids, 28: 1069-71(June 1967).

The resistivity, thermoelectric power, and Hall coefficient for ThN and Th_3N_4 were measured at 4 to 850°K (resistivity) and 4 to 375°K (other properties). The results are related to the electronic properties of the compounds. (UK)

4880 CERAMICS FOR HIGH-TEMPERATURE GAS-COOLED THERMAL NUCLEAR REACTORS. Ebeling, D. R. (Australian Atomic Energy Commission Research Establishment, Sydney). Mech. Chem. Eng. Trans., 55-63(Nov. 1966).

An engineering comparison is made of ceramics for use as moderators and fuel dispersants in high-temperature thermal reactors with comments on auxiliary applications. It is indicated that their major usefulness is in achieving a high temperature of operation. The major disadvantages of ceramics as unclad fuel dispersants are their brittle nature, which imposes additional limits on fuel element stresses, and their porosity, which may necessitate design for active circuits and clean-up systems. It is suggested that ceramics have economic potential for use in gas-cooled systems, provided designs are developed which can fully utilize their thermodynamic potential and mitigate or avoid the reprocessing and fabrication problems. (auth)

4881 A HIGH-TEMPERATURE ADIABATIC DROP CALORIMETER. THE ENTHALPIES OF $\alpha-Al_2O_3$, UC_2, AND US BETWEEN 330°K and 1700°K. MacLeod, A. C.; Hopkins, S. W. J. (Morganite Research and Development Ltd., Point Pleasant, Eng.). Proc. Brit. Ceramic Soc., No. 8, 15-30(June 1967).

From 8th Proceedings of the British Society on Thermodynamics on Ceramic Systems, London, Apr. 19-21, 1966. See CONF-660459.

The construction and operation of an adiabatic drop calorimeter for enthalpy measurements up to 1800°K is described. Enthalpy data determined for a sample of $\alpha-Al_2O_3$ provided by the National Bureau of Standards agreed with the values calculated from the NBS "corrected" equation with a mean derivation of less than 0.1%. The heat capacities of UC_2 and US were derived from enthalpy measurements made over the temperature range from 200 to 1500°K. (auth)

4882 THERMODYNAMICS OF NON-STOICHEIOMETRIC OXIDE SYSTEMS. Roberts, L. E. J.; Markin, T. L. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceramic Soc., No. 8, 201-17(June 1967).

From 8th Proceedings of the British Society on Thermodynamics on Ceramic Systems, London, Apr. 19–21, 1966. See CONF-660459.

Oxide systems based on the fluorite structure exhibits wide ranges of nonstoichiometry at high temperatures; the disorder mainly affects the anion sub-lattice, with the introduction of interstitial oxygen or of oxygen vacancies. The defects order at low temperatures to give complex superstructures. Structural evidence suggests that domains having a local structural configuration similar to that of the next ordered phase persist in the nonstoichiometric ranges, though long-range order is destroyed. The thermodynamic data are shown to be compatible with this view and to provide some further direct support. Thermodynamic data for solid solutions such as (U, Th)O_{2+x} and (U, Pu)O_{2-x} are compared with data for the binary systems UO_{2+x} and PuO_{2-x}; the enthalpy values are very different when cations of variable valence are sufficiently diluted with inert cations, so that the local configurations that can form in the binary systems can no longer occur. Rapid changes of thermodynamic properties can occur close to a stoichiometric composition when two types of defect can be formed with very different energies of formation. (auth)

4883 A THERMODYNAMIC STUDY OF DILUTE SOLUTIONS OF DEFECTS IN THE RUTILE STRUCTURE TiO_{2-x}, NbO_{2-x}, AND $Ti_{0.5}Nb_{0.5}O_{2\pm x}$. Alcock, C. B.; Zador, S.; Steele, B. C. H. (Imperial Coll. of Science and Tech., London). Proc. Brit. Ceramic Soc., No. 8, 231-45(June 1967).

From 8th Proceedings of the British Society on Thermodynamics on Ceramic Systems, London, Apr. 19-21, 1966. See CONF-660459.

The oxygen chemical potential was measured in the solids as a function of defect concentration and temperature in the range from 800 to 1000°C by means of solid-state electrochemical cells. The compositions of the phases were altered under controlled conditions by coulometric titration and equilibrium with appropriate H_2/H_2O gas mixtures. Values were obtained at nonstoichiometric compositions for $Ti_{0.5}Nb_{0.5}O_2$ and for oxygen-deficient TiO_2 and NbO_2. The results were analyzed to find the region of nonstoichiometry over which the dilute solution laws can be applied. The partial heats and entropies of solution of oxygen and the metallic species are discussed in terms of the Wagner-Schottky model. (auth)

4884 INTERACTION AND FRACTURE OF TITANIUM–BORON COMPOSITES. Metcalfe, Arthur G. (International Harvester Co., San Diego, Calif.). J. Compos. Mater., 1: 356-65(Oct. 1967).

A model is presented to explain premature fracture of titanium–boron composites as a result of interaction to form titanium boride. Three failure modes are identified. The titanium boride cracks at a strain of 2500×10^{-6} but the cracks result in a smaller stress concentration than the preexisting flaws in the boron up to a boride thickness of 1000 Å. Between 1000 and 5000 Å, failure initiates at the cracks in the boride at a strain that varies inversely with the square root of the thickness. Above 5000 Å of boride simultaneous failure of boride and boron filaments occurs. (auth)

4885 THERMOLUMINESCENCE OF ALUMINA. Kelly, P. J.; Laubitz, M. J. (National Research Council, Ottawa). J. Amer. Ceram. Soc., 50: 540-2(Oct. 21, 1967).

Results of measurements of thermoluminescence for γ-irradiated pure, and magnesia-doped alumina ceramics are presented. A self-consistent method of glow curve analysis led to results differing from those previously reported in the literature, with smaller trapping energies and realistic attempt-frequency factors. (auth)

4886 CHEMICAL AND PHYSICAL STUDIES OF OXYGEN-DEFICIENT TANTALUM PENTOXIDE. Kudrak, Daniel Robert. Ithaca, N. Y., Cornell Univ., 1967. 85p.

Thesis.

The $Ta-O_2$ system was investigated with the purposes of preparing oxides lower than Ta_2O_5 and of characterizing the mechanism of electron transport in the oxides. Initial experiments indicated that it was not feasible to oxidize Ta metal to an intermediate oxidation state. Later efforts were concentrated on finding a suitable reducing agent for the pentoxide, Ta_2O_5. A variety of reducing agents was tried at 1000 to 1500°C, all without success. It was concluded that the lower oxides previously reported, e.g., TaO and TaO_2, do not exist under ordinary conditions. During the course of the preparations, it was found that fusion of Ta_2O_5 powder (melting point approximately 1850°C) in a Ta container in high vacuum produced a hard, black, lustrous, crystalline material. This product was a rather good electrical conductor (room temperature resistivity 4.5×10^{-3} ohm-cm) and increased in weight

when heated in O_2. The product was a nonstoichiometric form of the high-temperature phase of Ta_2O_5 involving interstitial Ta. Its formula may be written $Ta_{2.11}O_5$. Samples were cut from the fused mass without regard to crystallographic orientation, and the resistivity, Hall coefficient, and thermoelectric power were measured as a function of temperature. When the electrical measurements were completed, the density of the sample was determined from the buoyancy effect of water on the immersed sample, and finally the same sample was heated in O_2 to determine its composition. Two samples were measured; they were identical in all their properties. The model of conduction mechanism that best fits the experimental data is that of a highly degenerate impurity metal with the conduction band of the pentoxide populated by electrons donated by interstitial tantalum atoms. However, a large fraction of normally available electrons are apparently trapped at lattice defect sites. The resistivity is metallic in nature in that it exhibits a positive temperature coefficient and a constant residual resistivity (0.63×10^{-2} ohm-cm) below 40°K. The thermoelectric power is also typically metallic, increasing monotonically from −10 micro v/degree at 90°K to −51 micro v/degree at 300°K. The temperature-dependent portion of the resistivity curve, as well as the entire thermoelectric power curve, are described rather well by the theory of electron scattering by optical vibrational modes of the lattice, using an estimated value of the parameter θ (Debye temperature of the lattice) at 350°K. The effective mass of the conduction electrons is equal to the rest mass. Because of its apparently strong electron-phonon coupling, the sample was considered likely to be a superconductor at low temperatures. Consequently the resistivity was monitored down to a temperature of 1.8°K, but no evidence of a superconducting transition was observed. The transition might occur at a still lower temperature. (Disser. Abstr.)

Structure and Phase Studies

Refer also to abstracts 4098, 4100, and 4861.

4887 (BM-RI-6983) HAFNIUM–CARBON PHASE DIAGRAM. Deardorff, Donald K.; Copeland, M. I.; Adams, R. P. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Nov. 1966. 16p. Bureau of Mines Free.

The hafnium-carbon phase diagram was investigated. Alloys used to study this system were prepared from high-purity components by both consumable- and nonconsumable-electrode arc melting. Data for the diagram were obtained by metallography, optical pyrometry, thermal analysis, heat treatment, and x-ray diffraction. The data indicate that a carbide compound occurs over considerable range of composition, and that one of each of the following types of reactions occurs in the hafnium-carbon system: peritectoid, peritectic, and eutectic. The maximum melting temperature of hafnium carbide is 3,840°C at 49 to 50 at. % carbon, and the composition range of hafnium carbide at 2,150 to 2,380°C is from 37.0 to 48.5 at. % carbon. The hafnium α-β transformation temperature is raised on alloying with carbon from 1,750 to 1,890°C, where a peritectoid reaction isotherm occurs. Alloying hafnium with carbon increases the hafnium melting temperature from 2,190 to 2,250°C, at which temperature a peritectic reaction occurs. Hafnium carbide and carbon react at 3,055°C to form a eutectic of 68.3 at. % carbon. (auth)

4888 (EUR-3563e) A COMPARISON OF THE Pu–O SYSTEM WITH THE RARE EARTH OXIDE SYSTEMS Ce–O, Pr–O, AND Tb–O. Blank, H. (European Atomic Energy Community, Karlsruhe (West Germany). Inst. of Transuranium Elements). June 21, 1967. 42p. Dep.

The phase diagrams and lattice parameters of the cubic and pseudo cubic phases of the Pu–O system are compared with those of the Ce–O, Pr–O, and Tb–O systems. The features common to all four phase diagrams are an extended region MO_{2-x} above 650°C, a miscibility gap between MO_2 and $MO_{1.83}$ or $MO_{1.70}$ at low temperatures and a modified C-type phase at higher temperatures for $O/M \leq 1.69$. This leaves $1.83 = O/M = 1.71$ as the region where differences exist between the two groups of diagrams. In this range the rare earth oxides exhibit disturbed pseudo cubic intermediate phases whereas the Pu-O system does not show them. This difference in behavior can be correlated with the change of the lattice parameters of the cubic and pseudo cubic phases with the O/M-ratio and with their dependence on temperature. It gives indications on the type of interaction between the lattice defects in these oxide systems. For the Pu–O system it is shown that a new modified phase diagram is in good agreement with published x-ray and EMF data. (auth)

4889 (EUR-3564e) METALLOGRAPHIC AND X-RAY INVESTIGATION OF PLUTONIUM OXIDES AT ROOM TEMPERATURE. Sari, C.; Benedict, U.; Blank, H. (European Atomic Energy Community, Karlsruhe (West Germany). Inst. of Transuranium Elements). June 19, 1967. 55p. Dep.

Plutonium oxides in the range $1.61 \leq O/Pu \leq 2.00$ were investigated at room temperature both by metallography and by x-ray analysis, mainly on samples quenched from about 1500 to 5°C. Specimens with compositions $1.627 < O/Pu \leq 1.69$ are single phase α-type at 650°C and this phase can be quenched to room temperature to a high degree. Specimens with $1.69 < O/Pu \leq 1.995$ invariably transform to a two-phase structure $\alpha + \gamma$ ($\gamma = PuO_{2-x}$) on quenching through the 650°C phase boundary known from previously published phase diagrams. These phase diagrams have to be modified on the basis of the present results in two respects: α-Pu_2O_3, which was taken earlier as a compound with $O/Pu = 1.61$, exists as an extended phase in the range $1.62 < O/Pu \leq 1.69$ at $T > 650$°C; the oxygen-deficient fluorite phase PuO_{2-x} at 350°C in equilibrium with the α-phase has a composition about $PuO_{1.995}$ instead of $PuO_{1.98}$ as claimed before; reinterpretation of published data on the Pu–O system suggest, that above 650°C the α-phase is separated from the highly oxygen deficient γ-phase (PuO_{2-x}) by a narrow two-phase region $\alpha + \gamma$ in the range $1.69 \leq O/Pu \leq 1.72$. The variation of the low oxygen side of the boundary of the α-phase field with temperature near $O/Pu = 1.62$ is not yet known with certainty. Also the details of the transformation process and their variation with oxygen content for samples in the region $1.70 < O/Pu < 1.995$ cannot be explained at present. (auth)

4890 (KFK-521) QUASIBINAERE PHASENDIAGRAMME DER SYSTEME THULIUMOXIDE–ACTINIDENOXID (ThO_2,UO_2, NpO_2,PuO_2) UNTERHALB 1700°C. (Quasibinary Phase Diagrams of the System Thulium Oxide–Actinide Oxide (ThO_2,UO_2,NpO_2,PuO_2) Below 1700°C). Leitner, Lutz (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Feb. 1967. 86p. (In German). Dep.

In the system ThO_2–$TmO_{1.5}$ the temperature dependence of the limiting composition of the individual phases was determined by x-radiographic methods. The phase diagram at 1250 to 1700°C was constructed. The ir spectra of mixed oxides of the various phase regions were obtained. The expansion coefficients α of a mixed oxide (7.5 mol % $TmO_{1.5}$) were determined as $\alpha = 8.0 \times 10^{-6}$/°C at 25 to 1250°C and that of Tm_2O_3 as $\alpha = 8.6 \times 10^{-6}$/°C at 25 and 1200°C. The integral heats of solution of the solutions of $MeO_{1.5}$(Me = Ho, Tm, Lu, and Sc) in ThO_2 and that of ThO_2 in $MeO_{1.5}$ were estimated. The phase diagrams of the system XO_2–$TmO_{1.5}$ (X = U, Np, Pu) at 1250 and 1550 or 1700°C were constructed on the basis of the determination of the temperature dependence of the limiting composition. The rhombohedric $NpO_2 \cdot 6TmO_{1.5}$ compound has the following lattice parameter: $a = 6.469$ Å, $\alpha = 99.0$, and rhombohedric mole volume = 259.51 (Å)^3. In the system $(U_x, Tm_{1-x})O_{2.00}$, a homogeneous cubic phase with the fluorite structure extends at 1240°C from 0 to 52.5 mol % $TmO_{1.5}$. The system UO_{2+x}–$MeO_{1.5}$ (Me = Tm and Yb), the temperature dependence of the fluorite phase, which extends up to 60 mol % $MeO_{1.5}$, was investigated. In the system UO_{2+x}–$TmO_{1.5}$ ir spectra of individual mixed oxide preparations from the various phase regions were obtained. In the same system a homogeneous rhombohedric phase was observed from 72 to 85.7 mol % $TmO_{1.5}$. The phase diagrams of both systems were constructed. The solubilities in the system XO_2–$TmO_{1.5}$ and the fluorite phase limits of UO_{2+x}–$MeO_{1.5}$ (Me = Tm and Yb) were tabulated. (tr-auth)

4891 TERNARY SYSTEMS OF ZIRCONIUM–CHROMIUM–BORON AND ZIRCONIUM–TUNGSTEN–BORON. Voroshilov, Yu. V.; Lakh, V. I.; Stadnyk, B. I.; Kuz'ma, Yu. B. (Lvov State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1597-1600 (Sept. 1967). (In Russian).

The ternary systems Zr–Cr–B and Zr–W–B were studied by x-ray analysis and the isothermal cross sections were constructed. The absence of ternary compounds in these systems was established. (tr-auth)

4892 THE PEROVSKITE FIELDS IN PORTIONS OF THE SYSTEMS BaO–$LuTaO_4$–B_2O_3, BaO–$YTaO_4$–B_2O_3, AND BaO–$LaTaO_4$–B_2O_3. Layden, G. K. (United Aircraft Corp., East Hartford, Conn.). Mater. Res. Bull., 2: 601-7 (June 1967).

Liquidus equilibria were investigated in portions of the BaO–$LaTaO_4$–B_2O_3 systems. Perovskite crystals having a composition $Ba_{0.925}Lu_{0.550}Ta_{0.500}O_3$ were grown by cooling a melt composition in the perovskite primary phase region of the Lu system. The perovskite primary phase region was not located at analogous compositions in the La system. These systems are compared with the previously reported BaO–$YTaO_4$–B_2O_3 system, and phases that crystallize from analogous melt compositions in the different systems are discussed in terms of the sizes of the rare earth ions. (BBB)

4893 CRYSTALLINE STRUCTURE OF RARE EARTH OXYSULFIDES: $Ln_2O_2S_2$. Ballestracci, R. (CEN, Grenoble, France). Mater. Res. Bull., 2: 653-60 (July 1967). (In French).

The rare earth oxysulfides, $Ln_2O_2S_2$, were prepared in the pure state (where Ln = La, Pr, Nd) by heating Ln_2O_2S with an excess of S in a sealed tube at 600 to 800°C. A pure form could not be obtained for the Sm and Gd compounds, as shown by their x-ray diffraction patterns. The $Ln_2O_2S_2$ structure as determined by x-ray and neutron data could be described as alternate layers perpendicular to the C axis with $(Ln_2O_2)^{2+}$ and $(S-S)^{2-}$ composition. The $(S-S)^{2-}$ ions are ordered in a plane layer but these planes are disordered along the c axis. The structure is related to other rare-earth compound structures and supports the concept of the complex cation $(Ln_2O_2)^{2+}$. The structure of the oxysulfides is compared with that of the oxychlorides and the oxymolybdate. (BBB)

4894 BEHAVIOR OF BORIDE DISPERSIONS IN TUNGSTEN AT HIGH TEMPERATURE. Kubota, Tadashi (Mitsubishi Atomic Power Industries, Inc., Omiya, Japan). J. Nucl. Sci. Technol. (Tokyo), 4: 582-3(Nov. 1967). (In German).

Five borides, TiB_2, ZrB_2, WB, TaB_2, and W_2B_5 were dispersed in tungsten and the behavior of these borides was investigated. Boride powders were mixed in a 30 wt % ratio with pure tungsten and put into steel tube with a tungsten wire at its middle axis. The wire was heated to 2500°C. The microstructure and x-ray diffraction of the dispersions were studied. The results showed that when reacting with tungsten, TiB_2 formed TiB_2 plus W_2B; ZrB_2 formed W_2B; WB changed to W_2B; TaB_2 formed TaB_2, W_2B, and WB; and W_2B_5 changed to W_2B. (L.C.L.)

4895 DOUBLE OXIDES CONTAINING NIOBIUM, TANTALUM, OR PROTACTINIUM. III. SYSTEMS INVOLVING THE RARE EARTHS. Iyer, P. N.; Smith, A. J. (Univ. of Sheffield, Eng.). Acta Crystallogr., 23: 740-6(1967).

Those regions of the systems $R_2O_3-M_2O_5$ (R = rare earth or other trivalent metal, M = Nb, Ta, or Pa) rich in M_2O_5 were investigated. The niobium and tantalum systems yield series of compounds RM_3O_9, which have a form of perovskite structure. Cell constants for these and, in the cases of $LaNb_3O_9$ and $LaTa_3O_9$, structure analyses based on single-crystal data are presented. The unit cells of a few compounds, such as RM_5O_{14}, are also reported. The protactinium systems do not resemble those of niobium and tantalum but extensive solid solutions of fluorite structure are formed. Cell parameters are presented and their variation with the size of the R ion and with the R to Pa ratio is discussed. (auth)

4896 CONTRIBUTION TO THE STUDY OF THE U–C–O SYSTEM. Bazin, J.; Accary, A. (CEN, Saclay, France). Proc. Brit. Ceramic Soc., No. 8, 175-91(June 1967).

From 8th Proceedings of the British Society on Thermodynamics on Ceramic Systems, London, Apr. 19–21, 1966. See CONF-660459.

The exact nature of the phases that appear in the univariant equilibrium usually written $3UC_2 + UO_2 \rightleftharpoons 4UC + 2CO$ were studied over the temperature range from 1720 to 2070°K. The phases were determined by x-ray diffraction. The UC phase contains from 200 ± 200 ppM oxygen at 1720°K to 600 ± 200 ppM at 2070°K. The UO_2 phase proved to be stoichiometric in contrast to the values for the lattice parameter of UO_2 available in the literature. From considerations of lattice parameters and thermodynamics, under equilibrium conditions the UC_2 phase contains some dissolved oxygen, probably a few per cent. The equation above should therefore be replaced by: $(3-2x)U[C_{2(1-y)},O_y] + (1-3y+2x)UO_2 \rightleftharpoons (4-3y)U(C_{1-x},O_x) + (2-3y+xy)\,CO$. (auth)

4897 NON-STOICHEIOMETRY IN TERNARY OXIDES WITH THE FLUORITE STRUCTURE. Hoch, M.; Yoon, H. S.; Silberstein, A. (Univ. of Cincinnati). Proc. Brit. Ceramic Soc., No. 8, 247-57(June 1967).

From 8th Proceedings of the British Society on Thermodynamics on Ceramic Systems, London, Apr. 19–21, 1966. See CONF-660459.

Ternary oxides with the fluorite structure can be written as $Me^{\prime}_{\gamma}Me^{\prime\prime}_{1-\gamma}O_{2+x}$ (one cation being in two valency states), or as a solution of oxides AO_m, BO_n, and CO_r. The cation sites that form a fcc structure are completely filled. If $x > 0$, the excess anions are accommodated in octahedral interstices; if $x < 0$, some of the tetrahedral sites are empty. When $x > 0$, a large single-phase fluorite structure exists, as in $U_{1-y}Ce_yO_{2+x}$ and $U_{1-y}Th_yO_{2+x}$. When $x < 0$ either a single phase with a defect fluorite structure is present, or two phases, each having a defect fluorite structure, co-exist. The latter occurs if a defect fluorite phase containing only one cation in two valency states is possible (e.g., $CeO_2-CeO_{1.5}$). The defect oxygen sub-lattice, in this case, must be considered as forming complexes between the vacancy and oxygen ions; these complexes are responsible for the co-existence of two defect fluorite phases. (auth)

4898 EXPERIMENTAL OBSERVATIONS IN THE POTASSIUM–GRAPHITE SYSTEM. Salzano, F. J.; Aronson, S. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 47: 2978-81(Oct. 15, 1967). (BNL–11351).

A gravimetric Knudsen effusion technique was developed to study the phase equilibria and thermodynamic properties of potassium–graphite lamellar compounds. Using this technique the existence of a $C_{16}K$ phase was established and phase equilibria in the potassium–graphite, rubidium–graphite, and cesium–graphite systems are shown to be completely analogous. The trends in the heats of reaction of cesium–graphite, rubidium–graphite, and potassium–graphite compounds are discussed. (auth)

4899 SYSTEM OF $ReOCl_4$–$WOCl_4$ AND PURIFICATION OF RHENIUM OXYTETRACHLORIDE BY FRACTIONATION. Nisel'son, L. A.; Nikolaev, R. K.; Orshanskaya, Z. N. Izv. Akad. Nauk SSSR, Metal., No. 4, 209-12(July-Aug. 1967). (In Russian).

A phase diagram was constructed for $ReOCl_4$–$WOCl_4$ system and the liquidus temperature was determined. Studies of the liquid–vapor equilibrium of the $ReOCl_4$–$WOCl_4$ system showed that it follows Raoult law. An attempt of effective purification of $ReOCl_4$ from tungsten impurities in fractionating column was not successful. (R.V.J.)

4900 COMPOUND FORMATION IN THE SYSTEMS LITHIUM–CARBON AND LITHIUM–BORON. Secrits, D. R. (General Electric Co., Schenectady, N. Y.). J. Amer. Ceram. Soc., 50: 520-23(Oct. 21, 1967).

The phases present in the 2 to 50 at. % lithium region for the system lithium–carbon below 700°C are carbon and stoichiometric Li_2C_2. The unit cell of Li_2C_2 was identified as primitive monoclinic. A lithium boride phase of composition $LiB_{10.85\pm0.35}$ was synthesized in the lithium–boron system for samples containing up to 50 at. % lithium. The Debye–Scherrer X-ray powder pattern for this phase can be indexed on the basis of a tetragonal unit cell. Lithium reacts with boron carbide to form lithium carbide and lithium boride. (auth)

4901 CUBIC PHASE STABILIZATION OF TRANSLUCENT YTTRIA–ZIRCONIA AT VERY LOW TEMPERATURES. Mazdiyasni, K. S.; Lynch, C. T.; Smith II, J. S. (Wright-Patterson Air Force Base, Ohio). J. Amer. Ceram. Soc., 50: 532-7 (Oct. 21, 1967).

Simultaneous decomposition of yttrium and zirconium alkoxides was used to obtain an almost ideal mixture of powders of high surface activity. From this powder a translucent body, "Zyttrite," was made with a grain size of less than 1μ. The mixed oxide was consolidated into a stabilized body by firing at 1000°C for 30 min. This is indicative of a phenomenal increase in solid state reactivity. High-density fully stabilized cubic solid solutions of 6 mole % $Y_2O_3-ZrO_2$ were obtained on sintering at 1450°C. A typical specimen had a density of 5.9 g/cm³, a coefficient of thermal expansion of 11×10^{-6} in./in.°C, and a grain size of 2 to 4μ. Test pieces withstood 2200°C firings in air for 262 hr with grain growth of 35 to 50μ and virtually no change in composition, density, or stabilization. (auth)

4902 DEFORMATION MECHANISMS IN POLYCRYSTALLINE GRAPHITE. Slagle, O. D. (Battelle-Northwest, Richland, Wash.). J. Amer. Ceram. Soc., 50: 495-500(Oct. 21, 1967).

The microstructure of SGBF graphite was observed under tensile and compressive stresses. Increasing stress generated extensive cracking parallel to the layering direction in the particles. Such cracking, however, was not necessarily directly attributable to the low strength of the graphite crystallites in the c direction but rather to flaws or weak regions occurring between the layer planes. For tensile stress, the cracks were perpendicular to the direction of the applied stress, whereas in compression, the cracking was parallel to the applied stress. Analysis of the stress-strain relations for SGBF graphite in tension indicates a discrepancy with the previously proposed plastic deformation model. The discrepancy is attributed to the effect of the observed cracking on the internal stress distribution. An alternative explanation is proposed on the basis of internal stresses, localized cracking, and interlayer slip. (auth)

Radiation Effects

Refer also to abstracts 4816 and 4827.

4903 (CEA-R-3289) MESURES DE DENSITES D'ECHANTILLONS DE BIOXYDE D'URANIUM ET DE CARBURE D'URANIUM IRRADIES A BASSE TEMPERATURE. (Measurement of the Density of Uranium Dioxide and Uranium Carbide Samples Irradiated at Low Temperature). Kingery, William-David; Kauffmann, Yes; Bruet, Michel; de Bernardy de Sigoyer, Bruno

(Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). July 1967. 18p. (In French). Dep.

Density measurements at 21°C and after annealing for 10 hours at 400°C have been carried out on uranium dioxide and uranium carbide samples previously irradiated at low temperature up to values of 0.86×10^{16} and 0.83×10^{17} fissions/cm^3. The changes in the density before and after irradiation are compared with measurements of lattice parameter change. In the case of uranium dioxide, the agreement is satisfactory for an exposure of 0.86×10^{16} fissions/cm^3. On the other hand, for an exposure of 0.83×10^{17} fissions/cm^3 the decrease in the density is greater than what could have been expected from the increase in lattice parameter. (auth)

4904 TEMPERATURE DEPENDENCE OF THE SURFACE STRUCTURE OF ION-BOMBARDED Si SINGLE CRYSTALS. Punzel, J. (Technische Univ., Dresden). Phys. Status Solidi, 24: K1-2(Nov. 1, 1967).

Single Si crystal slices were bombarded with 22-keV He ions while under observation in the emission electron microscope. The (111) surface was studied at bombardment temperatures of −180, 20, 300, and 770°C; the resulting structures are dependent on temperature. (D.L.C.)

4905 ON THE NATURE OF DISLOCATION LOOPS IN NEUTRON-IRRADIATED SAPPHIRE. Gulden, T. D. (Berkeley Nuclear Labs., Eng.). Mater. Res. Bull., 2: 49-53(Jan. 1967).

Prismatic dislocation loops have been observed in neutron-irradiated sapphire ($\alpha - Al_2O_3$), most loops being found to be located on $(10\bar{1}0)$ prism planes. The nature of the loops has not been unambiguously determined, but they appear to be an interstitial type, which is consistent with the observation of interstitial loops in neutron-irradiated UC, UO_2, and BeO. Electron diffraction contrast experiments are described which uniquely defined the Bergers vector of prism plane dislocation loops in neutron-irradiated sapphire as $\vec{b} = \frac{1}{3}\langle a\bar{o}\bar{a}c\rangle$. This is the same Burgers vector that characterizes the loops in oxygen ion-irradiated sapphire. The loops in the neutron-irradiated specimens were so small that tilting techniques could not be used to determine whether they are made up of condensed vacancies or interstitial ions, but it seemed reasonable to assume that the loops are interstitial type as in oxygen ion-irradiated sapphire. (BBB)

4906 THREE-REGION ANALYTICAL MODEL FOR THE DESCRIPTION OF THE THERMAL BEHAVIOR OF LOW-DENSITY OXIDE FUEL RODS IN A FAST-REACTOR ENVIRONMENT. Sayles, Charles W. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 458-9(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4907 GAS-COLLECTION TECHNIQUE FOR MEASUREMENT OF FISSION-GAS RETENTION IN IRRADIATED $MoUO_2$ CERMETS. Patrick, A. J. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 10: 672-3(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4908 EFFECT OF RADIATION ON RARE-GAS DIFFUSION IN CRYSTALS. Elleman, T. S. (North Carolina State Coll., Raleigh); Mears, L. D.; Christman, R. P. Trans. Amer. Nucl. Soc., 10: 509(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4909 IRRADIATION TESTING OF UO_2 FUEL ELEMENTS CONTAINING BURNABLE POISON ADDITIONS. Koziol, J. J.; Mahagin, D. E.; Christopher, S. S. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc., 10: 509-10 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4910 CRITICAL BUBBLE SIZE IN SODIUM-BONDED CERAMIC FUELS. Rutland, L.; Cherry, B. H.; Israel, S. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 10: 471-2(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4911 FAST-REACTOR IRRADIATION OF (UPu)C FUEL RODS. Strasser, A. A. (United Nuclear Corp., Elmsford, N. Y.); Stahl, D.; Martin, R. Trans. Amer. Nucl. Soc., 10: 472-3 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4912 PERFORMANCE OF MIXED-CARBIDE FUEL RODS UNDER FAST-REACTOR CONDITIONS. Brown, F. L.; Neimark, L. A.; Koprowski, B. J.; Kittel, J. H.; Ayer, J. E.; Kruger, O. L. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 473-5(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4913 PERFORMANCE OF MIXED-OXIDE FUEL PINS IRRADIATED IN A FAST REACTOR TO 50,000 MWD/T. Nelson, R. C.; Rubin, B. F.; Kendall, W. W.; Baily, W. E. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 10: 460-1(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4914 HIGH-BURNUP PERFORMANCE OF MIXED-OXIDE FUEL TO 120,000 MWD/T. Perry, K. J.; Nelson, R. C.; Rubin, B. F. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 10: 461-2(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

4915 INFLUENCE OF IRRADIATION TEMPERATURE ON THE RADIATION STABILITY OF COATED-PARTICLE FUEL. Luby, C. S. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-167. Nucl. Appl., 3: 728-36(Dec. 1967).

Irradiation tests to evaluate coated-particle fuels under high temperature, high burnup, and high fast-neutron dose conditions were designed so that the irradiation parameters could be measured and controlled closely. The coated particles used consisted of two-layer (BISO) and three-layer (Triplex) pyrolytic carbon coatings on fuel particles of the carbide or oxide of thorium and/or uranium. In the irradiation experiments, the coated particles were tested at temperatures up to 1900°C, fuel burnups up to 20% fissions per initial heavy metal atom (FIMA), burnup rates up to 20% FIMA per month, and fast-neutron doses up to 2.7×10^{21} n/cm^2 (E > 0.18 MeV). Correlations between the irradiation temperatures and other important radiation and materials parameters are presented showing the effects of these parameters on the stability of the BISO and Triplex coated fuel particles. These studies show that the temperature of irradiation is one of the most important parameters affecting coated-particle fuel stability under irradiation. This is believed to be due to the dependence of the fission gas pressure on irradiation temperature and the deleterious effect that an increase in this pressure has on the coating. Thicker coatings are required for high-temperature operation. The studies also demonstrated that coated particles with two- and three-layer pyrolytic-carbon coatings and adequate fuel contents have good stability well beyond the temperatures anticipated in an HTGR. (auth)

4916 LATTICE CONTRACTIONS ASSOCIATED WITH THE NEUTRON IRRADIATION OF SELF-BONDED SILICON CARBIDE. Ferguson, I. F. (United Kingdom Atomic Energy Authority, Springfields, Eng.). Phil. Mag., 16: 635-6(Sept. 1967).

Self-bonded SiC was irradiated at 250 and 700°C to fast neutron doses of 4.77×10^{20} and 1.98×10^{20} nvt, respectively. The unit cells of the phases present (Si, α- and β-SiC) were measured after irradiation and after various post-irradiation heat treatments. Under certain conditions the Si and α-SiC lattice parameters decreased below their unirradiated values. (auth)

4917 GAMMA-INDUCED ABSORPTION BANDS ASSOCIATED WITH Tl^+, Pb^{2+}, OR Bi^{3+} IN POTASSIUM BORATE GLASSES. Bishay, A. M.; Maklad, M. S. (Atomic Energy Establishment, Cairo, American Univ., Cairo). J. Amer. Ceram. Soc., 50: 503-8(Oct. 21, 1967).

Gamma irradiation of potassium borate glasses containing about 1.8 mole % Tl^+, Pb^{2+}, or Bi^{3+} resulted in two induced absorption bands which the authors call T and L bands. The T band was observed at about 1.1, 1.55, or 1.8 eV, and the L band was observed at about 1.8, 2.6, or 2.7 eV in alkali borate glasses containing Tl^+, Pb^{2+}, or Bi^{3+}, respectively. The shifting of the band positions to higher energies was attributed to the increasing polarizing power of these ions as in the case of the F band induced in alkali halides. The effect of the addition of cerium on the intensity of the T and L bands induced in glasses containing lead or thallium and prepared under different melting conditions suggested strongly that these two bands are associated with electron trap centers near these ions. (auth)

Plastics and Other Materials

Refer also to abstracts 4731, 6135, and 6176.

4918 (EUR-3631f) QUELQUES EFFETS ELECTRIQUES DANS LE TERPHENYLE. (Some Electric Effects in Terphenyl). Bauch, R.; Diletti, F.; Hoepper, M.; Van Rutten, F. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). July 10, 1967. 40p. (In French). Dep.

Electrical conductivity and Seebeck effect of terphenyls have been measured. The charge of particles suspended in terphenyls and the electroviscosity of such a suspension has been investigated. The influence of such electric effects on fouling deposition is discussed. (auth)

4919 DISLOCATION DAMPING IN GRAPHITE DOPED WITH ICl. Saito, Michihiro; Tsuzuku, Takuro (Nihon Univ., Narashino, Japan). Jap. J. Appl. Phys., 6: 1339(Nov. 1967).

Results of a study of the impurity-dope effects of ICl on reactor grade graphite are presented. Internal friction and resonant frequency measurements on the original graphite samples and on those doped with 0.075% and 0.24% ICl/C are shown as functions of temperature. It is concluded that the damping mechanism in the ICl-doped graphite is the same as in Br-doped specimens. (P.G.C.)

4920 GASIFICATION OF REACTOR GRAPHITE WITH CARBON DIOXIDE AND WATER VAPOR. Hedden, K.; Loewe, A. (Univ., Muenster, Ger.). Carbon, 5: 339-53(Sept. 1967). (In German).

The gasification of nuclear graphite with CO_2 in the pressure range of 0.1 to 1 atm CO_2 and 0 to 0.7 atm CO at temperatures between 980 and 1120°C was investigated in a batch operated recirculation reactor. A rate equation of the Langmuir-Hinshelwood type was not suited to represent the experimental results, because small CO pressures were found to have a relatively stronger inhibiting effect than high CO pressures. The same graphite was used to study the CO_2-C reaction with small partial pressures of CO_2 ranging from 0.4 to 2 mm Hg in the presence of 0 to 2 mm Hg CO in He as a carrier in a continuously operated recirculation reactor at a total pressure of 1 atm. The CO inhibition was considerably stronger than calculated from the rate equation which was determined in the high pressure range. Moreover, the inhibition by a definite CO content decreased with increasing partial pressure of CO_2. The measurements of the rates of the H_2O-graphite reaction covered a pressure range of 0.2 to 0.8 mm Hg H_2O in He as a carrier at temperatures of 940 to 1030°C. H_2O was found to be 17 times more reactive than CO_2 at 1000°C. Both products, H_2 and CO (0 to 0.8 mm Hg), inhibit the reaction. In agreement with the results of the CO_2-graphite reaction the extent of the observed inhibiting effect was much stronger than expected from studies of other authors at H_2O pressures of about 1 atm. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 5064, 5154, 5158, 5174, 5177, 5178, 5241, 5469, 5483, 5658, and 5905.

4921 (COO-382-75) RADIATION AGES AND GAS-RETENTION AGES OF CARBONACEOUS CHONDRITES AND OF UNEQUILIBRATED ORDINARY CHONDRITES. Heymann, D.; Mazor, E. (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies). [1966]. Contract AT(11-1)-382. 38p. (CONF-670309-4; SM-87/44). Dep. CFSTI.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, France.

Helium, Ne, and Ar were determined by mass spectrometry in 25 carbonaceous chondrites, and in 12 unequilibrated ordinary chondrites (UOC). The occurrence of primordial inert gases, and the possibility of severe diffusion losses in certain carbonaceous chondrites leads to the following considerations: (1) U, Th–He ages cannot be estimated for the C1 and C2 types of carbonaceous chondrites; (2) only "minimum" $^{3}He_{c}$ ages can be estimated for the C1 and C2 chondrites; and (3) $^{38}Ar_{c}$ ages cannot be estimated for any of the meteorites, except Karoonda. The radiation ages of the carbonaceous chondrites and of the UOC are not grossly different from those of the ordinary chondrites. However, the following trends can be noted: (1) the ages of the C1 and C2 carbonaceous chondrites are on the average shorter than those of the ordinary chondrites; none of the former is greater than 15 Myr; (2) four, perhaps five C2 carbonaceous chondrites, Boriskino, Cold Bokkeveld, Haripura, Nawapali, and Nogoya come from a single collision 0.1 to 0.6 Myr ago, with the most likely date of 0.2 ± 0.1 Myr. (auth)

4922 (UCRL-50309) NUMERICAL INVESTIGATION OF THE ENERGY BALANCE OF THE PLANET MARS. Coffin, Monty D. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 16, 1967. 62p. Dep. CFSTI.

Thesis.

An effort was made to simulate the gross features of the energy balance of the planet Mars. A six-level atmospheric model was used. Energy-transfer processes in the atmosphere are coupled to heat conduction and energy storage in the surface layers of the planet. A two-dimensional model is used so that calculations can be made throughout annual orbital periods. Simplified methods, appropriate to the Martian atmosphere, are developed for treating solar radiation absorption, longwave radiation transport, and vertical convective transport. The use of CO_2 as the only active volatile in the Martian atmosphere gives results which appear to be consistent with observations. In particular, the formation and dissipation of the polar caps is in good agreement with observations. The surface energy balance is found to be relatively independent of atmospheric effects including the horizontal transport of energy. There are indications that CO_2 in the upper atmospheric levels is in a saturated equilibrium state. (auth)

4923 OSCILLATING MODEL FOR GRAVITATIONAL COLLAPSE WITH PRESSURE GRADIENT. Narlai, Hidekazu (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 38: 740-1(Sept. 1967).

It is shown that a previous oscillating model for gravitational collapse with pressure gradient is one of three nonstatic and regular models corresponding to the three possible values of k. Restriction is made to the case k = 1. It is verified that the oscillating model is regular at any time throughout the interior region. (J.F.P.)

4924 PROPOSAL OF A COSMOGONIC MODEL AT THE DIMENSION SCALE OF GALAXY CLUSTERS. Ceccarelli, M. (Univ., Bologna); Dallaporta, N. Nuovo Cim. (10), 52B: 251-3 (Nov. 11, 1967).

A cosmological model is proposed which has as its primary feature: at a certain moment of the expansion of the Universe, due to some instability phenomena, matter became concentrated in large regions of space, somehow regularly distributed, undergoing a process of gravitational condensation into quasi-stable plasmoids having a mass of tens or hundreds of galaxies. (W.D.M.)

4925 RADIO EMISSION FROM BRIGHT GALAXIES. Braccesi, A.; Fanti-Giovannini, C.; Fanti, R.; Formiggini, L.; Vespignani, G. (Univ., Bologna). Nuovo Cim. (10), 52B: 254-61(Nov. 11, 1967).

Data are presented on the radio emission from 47 bright normal galaxies. Spectral indices are given for 21 of the 43 galaxies which had a radio source. (W.D.M.)

4926 IDENTIFICATION OF SEVEN 4C SOURCES WITH BLUE OBJECTS. Barbon, R. (California Inst. of Tech., Pasadena); Braccesi, A.; Fanti, R. Nuovo Cim. (10), 52B: 262-6 (Nov. 11, 1967).

Nine three-color plates taken with the 48-in. Schmidt telescope at Palomar were searched and 900 new blue stars were found. Overlays were prepared for 76 4C sources whose centers were in the area covered by the plates and 15 blue objects were found whose optical positions fell within the errors of the radio data. Using the Owens Valley interferometer at 2700 MHz and the 200 and 800 ft. E–W baselines, accurate right ascensions were obtained for the candidate sources. These positions led to a rejection of 8 of the candidates. For the other 7 the agreement in position is extremely good and the identifications can be assumed as certain. (W.D.M.)

4927 RADIO EMISSION FROM FOURTEEN PLANETARY NEBULAE AT 408 MHz. Ficarra, A. (Univ., Bologna). Nuovo Cim. (10), 52B: 267-9(Nov. 11, 1967).

Data are presented for 14 planetary nebulae at 408 MHz. Observations were made using the E–W arm of the Northern Cross radiotelescope. At present the half-power beam width of the instrument is 4′ E–W by 100′ N–S. For the very weak sources studied, effects of confusion permit only an accuracy of 2′ E–W by 15′ N–S. Since the average confusion is about 0.2 flux units, the measured flux densities of the weakest sources are accurate only to 30%. (W.D.M.)

4928 STRUCTURE AND VIBRATIONAL STABILITY OF WHOLLY CONVECTIVE RED DWARFS. Gabriel, M. (Univ., Liege). Ann. Astrophys., 30: 745-60(Sept.-Oct. 1967). (In French).

Models were computed for Kr 60 A ($0.27\ M_{\odot}$) and Kr 60 B ($0.16\ M_{\odot}$) taking into account the electrostatic interactions between gas particles. Both are found to be wholly convective except for a thin atmosphere in radiative equilibrium. An interpretation of the discrepancy between observational and theoretical values for the effective temperatures is suggested. The vibrational stability towards the three first modes is then examined. In both stars, they are unstable with e-folding times short relative to their lifetime. (auth)

4929 RADIAL PULSATIONS OF ROTATING STARS. I. Occhionero, F. (Laboratorio di Astrofisica, Frascati, Italy). Ann. Astrophys., 30: 761-71(Sept.-Oct. 1967).

The study of the pseudo-radial pulsations of a slowly rotating star is performed by inserting into the virial theorem the proper modes of radial pulsation of the corresponding nonrotating stellar model. One obtains in this way one part of the rotational correction to the proper frequencies of radial vibration. It is shown that the classical concept, that rotation is an intrinsically stabilizing agent, is not always correct. For equilibria far from marginal stability, rotation has a "geometric" influence upon the stellar oscillations and differentiates the even from the odd modes of pulsations. As this effect grows stronger the higher the order of the proper mode is plugged into the virial theorem and suggests the existence of genuinely rotational instabilities. (auth)

4930 ANALYSIS OF METALLIC LINE STARS. I. OBSERVATIONS OF 5 METALLIC LINE STARS. PHYSICAL STATE OF THE ATMOSPHERE. Praderie, F. (Observatoire de Paris, Meudon, France). Ann. Astrophys., 30: 773-822(Sept.-Oct. 1967). (In French).

Problems that arise from the situation of the metallic-line stars (A_m) in a transition zone of the H–R diagram are considered. Spectroscopic observations of five A_m stars and the automatic reduction of the data are described. A list of lines measured in the blue and visible part of the spectrum of ζ Lyr A are given. The accuracy of the measurements of equivalent line widths is discussed. An attempt is made to construct a model of an A_m star photosphere. After building a grid of preliminary models, the influence of the adopted abundances on the model and the contribution of some elements on the continuous absorption are discussed. Different criteria necessary to set the values of the effective temperature and the star gravity are discussed. It is found that the central region of the high-order Paschen lines is sensitive to the value of gravity. The effective temperature and gravity of the five observed stars are then determined. As these A_m stars exhibit high photospheric microturbulence, the photospheric models are extended towards the star interior to evaluate the convective flux available in the two unstable zones. With different choices of the temperature gradient in these zones, it is shown that the

velocity vector field produced by turbulent convection cannot explain the observed "microturbulence". The mechanical flux available to heat the chromosphere is evaluated. Rough computations of the effect of microturbulent velocities on atmospheric stratification are presented. Finally, the spectral distribution of the flux radiated by the models is computed. (auth)

4931 IDENTIFICATION OF AN EMISSION LINE OF QUASARS AT λ 2974 A. Vernon, P. (Observatoire de Paris, Meudon, France). Ann. Astrophys., 30: 823-5(Sept.-Oct. 1967). (In French).

An emission line is often observed in quasars at λ 2974 Å; this line has been identified with the [Ne V] λ 2974.8 Å line. It is shown that it is more likely the [O I] 2972.30 Å line. (auth)

4932 CONTRIBUTION TO A STUDY OF THE CHROMOSPHERE–CORONA TRANSITION ZONE. Delache, Philippe (Observatoire de Paris, Meudon, France). Ann. Astrophys., 30: 827-60(Sept.-Oct. 1967). (In French).

The purpose of this work is to study as quantitatively as possible the effects of transport processes on the abundances of "heavy" ions in the corona. Observations of the electron density and temperature in the mean corona are first reviewed and it is shown that the electron temperature is obtained from very indirect measurements, the interpretation of which could be greatly modified by the effects investigated here. Different very simple models of the temperature distribution are used which can be compared to other various existing models. It appears that the hydrostatic equilibrium hypothesis in the transition zone is not confirmed experimentally. A new explanation of this phenomenon is proposed. The existing discussions of abundance observations are reviewed critically and reasons for preferring Pottasch's to Athay's are given. Reasons for limiting the study to one space variable are given; atmosphere with spherical symmetry or with filamentary structures held by the magnetic field. Detailed calculations are presented. By applying the thermodynamics of irreversible processes the different phenomena to be treated simultaneously are outlined. The diffusion equations and the equations of ionization equilibrium lead to a system of coupled differential equations, the numerical stability of which are studied. Various methods are reviewed and the one used in the Meudon Observatory computer is presented. The results obtained show that it is possible to explain the heavy-element abundance variations throughout the transition zone, assuming reasonable temperature distributions and wind velocities comparable to solar wind velocities near the orbit of the earth. It is also found that ionization temperature is lower than electron temperature. It is then possible to use an approximate formulation which avoids solving a complicated system of differential equations and shows the effects which are important in the interpretation of observations. Indications are given towards a better use of experimental results. A model of the electron temperature T_e is proposed starting from Pottasch's mean curves which give the quantity $\int_R N_e^2 \, dV$ as a function of T_e(N_e = electron density, R_e = domain where the abundance is significant, dV volume element in R). Some possible consequences of transport effects are considered. (auth)

4933 CONTRIBUTION TO A STUDY OF THE TRANSITION ZONE BETWEEN THE PHOTOSPHERE AND THE CHROMOSPHERE STARTING WITH THE RESONANCE LINES OF Ca II AND Mg II. Dumont, Simone (Observatoire de Paris, Meudon, France). Ann. Astrophys., 30: 861-85(Sept.-Oct. 1967). (In French).

The resonance lines of Ca II and Mg II are computed for a number of models of the low chromosphere. These models depend on three parameters which are the value and the point height of the temperature minimum and the temperature gradient in the region above the temperature minimum. The condition that the computed profiles agree reasonably well with the observed profiles restricts severely the choice of possible models. The best results are obtained with a temperature minimum of 4200°K located at 450 km above the limb and a rather slow rise of the temperature above the minimum, corresponding to about 200° for 100 km. (auth)

4934 PHOTOMETRIC STATISTICAL STUDY OF GRANULATION. Levy, Michele (Observatoire de Paris, Meudon, France). Ann. Astrophys., 30: 887-94(Sept.-Oct. 1967). (In French).

A statistical study of a time sequence of high-definition photographs of solar granulation taken at the Pic du Midi Observatory is presented. The one-dimensional (space) power spectrum of the granulation is computed and compared with theoretical calculations and with the picture quality of previous observations. Two-dimensional space–time autocorrelation functions and the corresponding power spectra are also calculated. Some atmospheric effects are treated as a linear filtering of the data. (auth)

4935 STUDY OF SOLAR ACTIVITY AT 408 MHz. Clavelier, B. (Observatoire de Paris, Meudon, France). Ann. Astrophys., 30: 895-923(Sept.-Oct. 1967). (In French).

A Christiansen type array has been built in Nancay. It is operated at 408 MHz on an East–West base line of 1.5 km length and can locate solar sources to 20'' accuracy. Solar activity at 408 MHz has been studied at the beginning of the solar cycle. Weak centers can be related to coronal condensations but the major part of 408 MHz activity is observed as noise storms. The corresponding centers are small in extent, sometimes multiple, generally double. Their altitude is about 70,000 km above the photosphere. Directivity of this emission and E–W asymmetry have been studied; the characteristics of noise storm centers have been compared at 169 and 408 MHz. Comparison with optical observations shows that 408 MHz centers appear more often above abnormal active regions. A double radio center is associated with two distinct eruptive areas. (auth)

4936 NEGATIVE ABSORPTION OF CYCLOTRON AND GYROMAGNETIC RADIATION IN A NONCOLLECTIVE PLASMA. Heyvaerts, M. J. (Institut d'Astrophysique, Paris). Ann. Astrophys., 30: 925-51(Sept.-Oct. 1967). (In French).

An analytical expression is obtained for the cyclotron emission and absorption coefficients of a nonequilibrium plasma in a uniform constant magnetic field. The validity of two approximations is discussed: (1) The neglect of relativistic mass variation. (2) The neglect of the anisotropies of the distribution function. It is shown that when these approximations are valid, the absorption coefficient is always positive. It is shown that a simple physical interpretation of the amplification process can be found, which is faced with the predicted distribution function's evolution. This function obeys a diffusion equation which is established. (auth)

4937 TRITIUM LOSS FROM IRON METEORITES BY SOLAR WIND HYDROGEN. Wagener, K. (Univ. of California, San Diego, La Jolla). Z. Naturforsch., 22a: 1483-8(Oct. 1967).

An estimate of the diffusion loss of tritium from iron meteorites in space cannot be based, in a direct manner, on the results of diffusion measurements in the laboratory, because the hydrogen content of the samples in the laboratory is always higher by many orders of magnitude than is the tritium content of iron meteorites in space, which results from bombardment by cosmic rays. This is true because the kinetics of gas loss from a metal change with concentration and temperature, especially the kinetics of hydrogen loss from meteoritic iron, where the amounts of cosmic-ray-produced tritium are sufficiently small to be trapped completely by chemisorption of nickel. Estimates based on diffusion data for hydrogen in the laboratory lead to much higher rates of hydrogen loss than can be expected for cosmic-ray-produced tritium in meteorites. In this connection, however, the fact has to be considered that meteoritic iron in space may not only contain hydrogen isotopes derived from cosmic-ray-induced spallation processes, but also derived from solar wind bombardment. The steady-state hydrogen content of an iron meteorite, resulting from such bombardment in outer space, depends, of course, on the size and the structure of the meteoritic body. In general, the body will have to be assumed to possess a grain structure and this complicates the situation considerably. In any case, it can be shown that the steady-state hydrogen content is much higher that the tritium content and this makes it possible to use laboratory diffusion data in a calculation of the diffusion losses of tritium. By using the laboratory data of Festag, Fechtig, and Schultes, it can be shown that cosmogenic tritium will be lost almost completely whenever the temperature is close to 0°C, or higher. Only meteorites consisting of grains of a size exceeding several millimeters retain tritium at such temperatures. (auth)

4938 DEPENDENCE OF THE ^{8}B SOLAR NEUTRINO FLUX ON THE RATE OF THE REACTION ^{3}He(^{3}He,2p)^{4}He. Shaviv, Giora; Bahcall, John N.; Fowler, William A. (California Inst. of Tech., Pasadena). Astrophys. J., 150: 725-8(Nov. 1967).

The major nuclear physics uncertainty in the prediction of the ^{8}B neutrino flux from the Sun arises from incomplete knowledge of the rate of the reaction ^{3}He(^{3}He,2p)^{4}He. Since the neutrino flux, $\varphi_\nu(^8B)$, is expected to be the most important contributor to the experiment to detect solar neutrinos currently being carried out by Davis, the dependence of $\varphi_\nu(^8B)$ on the rate at solar temperature of the ^{3}He(^{3}He,2p)^{4}He reaction was calculated. (W.D.M.)

4939 NON-EQUILIBRIUM AND ENHANCED MIXING AT A PLASMA–FIELD INTERFACE. Lerche, I.; Parker, E. N. (Univ. of Chicago). Astrophys. J., 150: 731-2(Nov. 1967).

It is pointed out that the non-equilibrium effect may be important under certain astrophysical circumstances. At any place that a sharp interface between a magnetic field and a streaming plasma is observed, or expected from classical hydromagnetic theory, the

non-equilibrium and possible enhanced mixing are expected to occur. This suggests that the effect may play an important role in the theory of the interaction of comet gases with the solar wind. (W.D.M.)

4940 EFFECTS OF NUCLEAR REACTIONS WITH COSMIC RAYS IN COSMIC BODIES OF DIFFERENT SIZE AND COMPOSITION. Lavrukhina, A. K.; Ustinova, G. K.; Ibraev, T. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 11, 1350-60(Nov. 1967). (In Russian).

A method is proposed for the calculation of the depth distribution of cosmic radiation and cosmogenic isotopes in stony and iron meteorites of various size and in surface layers of large cosmic bodies: planets, the Moon, and asteroids. The calculation has been accomplished for iron meteorites and chondrites with radii of 10, 20, 30, 50, 80, 100 and 200 cm as well as for the 50-cm layer of a large body in supposing its ferrous, chondritic, basaltic, granitic and tectitic composition. The dependence of the depth distribution both on the sizes and on the chemical composition of cosmic bodies is analyzed. (auth)

4941 ULTRAVIOLET SPECTRA OF STARS. Underhill, Anne B. (Utrecht Univ.); Morton, Donald C. Science, 158: 1273-9(Dec. 8, 1967).

According to theories of model stellar atmospheres only stars of spectral types from O to about B3 may be expected to be bright in the ultraviolet-wavelength region. Observations of the strong resonance lines between 911.6 and 1900 Å will yield new information permitting construction of better models for the outermost layers of OB stars. However, an adequate theory of line-formation, including non-LTE effects, should be used if an accurate physical representation is to result. Already it has been demonstrated beyond doubt that O and B0 supergiants are surrounded by expanding atmospheres. The spectrum between 1900 and 3000 Å is formed chiefly in the same layers of the star as is the part of the spectrum observed with ground-based equipment; consequently, ground-based observations can be used to establish an adequate model. With such a model, observations of the absorption lines due to the first and second ions of the metals should permit new and reliable determinations of the abundances of Fe, Cr, Mn, and Ti in B stars. The photometric and the spectral observations so far available of O and B stars do not generally conflict seriously with the predictions of theory, provided that we use line-blanketed models for the comparison and that we correct for the effects of interstellar reddening when necessary. (auth)

4942 TYPE-III SOLAR BURSTS. Wagner, R. (Univ., Kiel). Z. Naturforsch., 22a: 1586-92(Oct. 1967). (In German).

In a previous paper formulas for the radio emission originating from the scattering of a plane plasma electron wave by thermal fluctuations were derived. These formulas are applied to the solar type-III bursts by starting from a cloud of electrons which transverses the solar corona, thereby exciting plasma waves. The electric field of the excited waves is estimated by an expression of the quasi-linear theory. The band width of these waves is about 10% of the local plasma frequency. The scattering mechanism considered here can account only for the faint and moderate type-III bursts without harmonic structure. The possibility to determine the thickness of the cloud in its variation with time is discussed. (auth)

4943 THERMAL X RAYS FROM NONTHERMAL RADIO SOURCES. Sartori, L.; Morrison, P. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 150: 385-403(Nov. 1967).

Thermal bremsstrahlung from dilute and very hot plasma is taken as the mechanism responsible for x-ray emission, at energies between about 1 and 100 keV, from those discrete x-ray sources that are of substantial linear diameter. ("Point" sources, like Scorpius X-1 and probably Cygnus X-2, are not discussed.) The Crab Nebula is regarded as the prototype of such diffuse sources: it holds a freely expanding dilute plasma about 1 to 2 light-years across, with a mass some tenths of a solar mass, radiative lifetime some 10^5 years, and thermal energy content between one and two orders of magnitude greater than the energy of the very dilute relativistic magnetized plasma which is known to account for the synchrotron emission seen all the way from the meter band to the ultraviolet. Although the x-ray intensity spectrum of the Crab roughly simulates a power law, it is here ascribed to a bremsstrahlung source with important contributions from plasma at two distinct temperatures, kT near 2 keV and near 40 keV. Some sign of this plasma is found in the asymmetrical distribution of polarized centimeter emission, which may indicate Faraday depolarization of the radio output wherever it traverses the hot central x-ray plasma. The large energy content of the hot plasma is the consequence of the inefficiencies of acceleration of the relativistic electrons; such a process during expansion stores most of the available energy in thermal plasma, provided only that the whole acceleration process was not completed during the earliest and densest phase of the expansion. The same phenomenon may take place on every scale, up to that of radio galaxies. Such nonthermal radio sources are then primarily x-ray objects, with the relativistic plasma of secondary energetic importance. Possible time courses of these aftermaths of explosions are discussed, and rough estimates given for present x-ray intensities of likely galactic and extragalactic sources. (auth)

4944 SEARCH FOR 8 TO 80 keV X-RAYS FROM THE LARGE MAGELLANIC CLOUD AND THE CRAB NEBULA. Seward, F. D.; Toor, A. (Univ. of California, Livermore). Contract W-7405-eng-48. Astrophys. J., 150: 405-11(Nov. 1967). (UCRL-70300).

An x-ray detector was flown on a sounding rocket launched from Johnston Atoll. The region scanned included that part of the south circumpolar sky containing the Large Magellanic Cloud. No x rays were detectable above background from the direction of the Large Magellanic Cloud. An upper limit of 8×10^{-9} ergs cm^{-2} sec^{-1} is derived for the x-ray flux between 8- and 60-keV photon energy. X rays were detected from the Sun and from the Crab Nebula. A spectrum is derived for photons between 10 and 40 keV from the Crab Nebula. The flux in this region is about the same as that measured in a previous experiment. (auth)

4945 RADIO RADIATION FROM NORMAL SPIRAL GALAXIES. Terzian, Yervant (Arecibo Ionospheric Observatory, Puerto Rico). Astrophys. J., 150: 413-19(Nov. 1967).

Five normal spiral galaxies were studied in detail at 430 and 611 MHz with the Arecibo Ionospheric Observatory's 1000-foot telescope. Radio maps are presented for the observed regions. The results include flux densities, spectral indices, radio sizes, and luminosities. Eleven other weak radio sources were detected in the surveyed regions, some of which may be associated with the observed galaxies, as appears to be the case with NGC 2903, which shows a triple radio source structure. (auth)

4946 TWO-DIMENSIONAL BRIGHTNESS DISTRIBUTIONS OF RADIO SOURCES FROM LUNAR OCCULTATION OBSERVATIONS. Taylor, J. H. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 150: 421-6(Nov. 1967).

Occultation of a radio source by the Moon provides data from which the strip brightness distribution of the source may be determined. This paper presents a method of reconstructing the complete two-dimensional brightness distribution of a source, given several occultations at different position angles. Reconstruction is accomplished by (i) computing the Fourier transform of each of the strip brightness profiles, (ii) interpolating in the transform plane between the available position angles to evaluate the transform function at the points of a square array, and (iii) inverting the Fourier transform in two dimensions to obtain the desired brightness distribution. As an example of the method, a map is presented of the radio galaxy 3C 192 with a resolution of 60″, derived from six occultations observed at 256 Mc/s. (auth)

4947 INVERSION OF FAN-BEAM SCANS IN RADIO ASTRONOMY. Bracewell, R. N.; Riddle, A. C. (Stanford Radio Astronomy Inst., Calif.). Astrophys. J., 150: 427-34(Nov. 1967).

A classical problem of data reduction in radio astronomy is how to reconstruct a two-dimensional brightness distribution over a source from fan-beam scans taken in various position angles. The integral equation underlying the problem arises also in interferometry and in the reduction of data from occultations. A new solution to the integral equation for the case of infinitely narrow fan beams has been obtained, which makes use of numerical operations on the observational data in the sky plane and does not require the computation of Fourier transforms. (auth)

4948 OBSERVATIONS OF THE HYDROGEN RECOMBINATION LINE 158 α IN GALACTIC H II REGIONS. Dieter, Nannielou H. (Univ. of California, Berkeley). Contract Nonr 222(66). Astrophys. J., 150: 435-51(Nov. 1967).

Observations of emission in the 158 α line at 1651 MHz of the hydrogen recombination spectrum in galactic H II regions are described. For thirty-nine nebulae, twenty well-known optical objects, eighteen thermal radio sources, and one previously uncatalogued object, velocities, intensities, and line widths are reported. Thirteen of the sources lie within the Cygnus X complex. Kinematic distances and estimates of the peculiar motions of the H II regions are derived. Line widths are used to estimate the size of internal motions; the average of mass motions in all the nebulae is 25 km/sec. A discussion of the determination of electron temperature from the ratio of line-to-continuum emission is presented. It is found that the assumption of a constant temperature within an H II region leads to the measurement of too low a temperature by this radio method. No definite conclusion concerning the presence of nonequilibrium effects is reached. (auth)

4949 AN UPPER LIMIT ON THE ABUNDANCE OF H_2 FORMED BY CHEMICAL-EXCHANGE REACTIONS. Wentzel, Donat G. (Univ. of Maryland, College Park). Astrophys. J., 150: 453-60(Nov. 1967).

Stecher and Williams proposed the formation of interstellar H_2 by chemical-exchange reactions on graphite grains. The fraction of hydrogen atoms converted to molecules, f, is computed according to their theory, but taking into account the radiative cooling by the molecules. During each cloud collision, f increases according to $\Delta f^2 \lesssim 3 \times 10^{-4}$; thereafter the temperature drops so as to stop further thermal reactions. Additional reactions on fast grains produce another increase $\Delta f \lesssim 0.4\rho$ (grains)/ρ (atoms). If H_2 is formed by chemical-exchange reactions, its abundance in typical clouds is less than 10%. The main body of this paper concerns the structure of the shocks in which the molecules form during cloud collisions. They are "isothermal" shocks whose "front" itself consists of an adiabatic shock and a region in which H_2 both forms and radiates. (auth)

4950 ORBITS IN SPIRAL GALAXIES AND THE VELOCITY DISPERSION OF POPULATION I STARS. Barbanis, B.; Woltjer, L. (Columbia Univ., New York). Astrophys. J., 150: 461-8(Nov. 1967).

Orbits of low-velocity stars in the gravitational field of a galaxy with spiral structure are studied on the basis of both first-order epicyclic theory and exact numerical integration of the equations of motion. An estimate is made of the matter density in the spiral arms in our Galaxy. The results show that the slow secular increase of the velocity dispersion of the low-velocity stars in our Galaxy can be interpreted as being due to the gravitational effects of large-scale spiral structure, provided either (a) the density in the spiral structure a few billion years ago was three times as large as at present, or (b) the spiral structures had always about the present density, but dissolved and randomly reformed every few hundred million years. These results provide upper limits on the past spiral pattern in our Galaxy because other effects may contribute to the observed velocity dispersions. (auth)

4951 THE ANOMALOUS COLOR–MAGNITUDE DIAGRAM OF THE REMOTE GLOBULAR CLUSTER NGC 7006. Sandage, Allan; Wildey, Robert (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 150: 469-82(Nov. 1967).

The color–magnitude diagram for NGC 7006 was obtained to V = 19.3 by a combination of photographic and photoelectric measurements. The horizontal branch occurs at V = 18.80. Interstellar reddening is small. Adopting $M_V = +0.5$ for the RR Lyrae variables gives a true modulus of $(m - M)_0 = 18.3$, a distance of 45 kpc from the Sun, and 15 kpc from the galactic plane. The metal abundance is low, as judged by $\Delta V = 2.6$ mag and by the spectroscopic and photometric criteria of Morgan and van den Bergh, and yet the distribution of stars along the horizontal branch imitates that of much higher metal-abundance clusters. This is the first clear violation of the heretofore unique correlation of metal abundance and density gradient along the horizontal branch. It shows that at least one additional parameter besides Z controls the stellar distribution along the branch. Models of Faulkner and of Faulkner and Iben suggest that the second parameter may be the abundance of helium. The NGC 7006 anomaly is present in many intergalactic globular clusters and in the clusters of the Small Magellanic Cloud, suggesting a difference in the second parameter between objects that have or have not partaken in the chemical evolution of the galaxy. NGC 7006 may not be gravitationally bound to the galaxy, in which case it was formed in the Local Group but outside the galactic halo. If future observations and more extensive model calculations can establish an abundance difference, ΔY, between objects inside and outside the Galaxy, then we would be able to conclude that some helium was made in the early history of the galactic system. This additional helium is then added to the pristine helium produced, for example, in the primeval fireball of a Friedman-type universe or in any other event that manufactured helium which preceded the formation of the Local Group of galaxies. (auth)

4952 ATMOSPHERES OF HELIUM STARS. Bohm-Vitense, Erika (Univ. of California, Berkeley). Astrophys. J., 150: 483-500(Nov. 1967).

The appearance of the spectra of helium stars as a function of hydrogen abundance is investigated theoretically for dwarfs (log g = 4.5) and giants (log g = 2) with effective temperatures T_{eff} = 7,350, 9,900, and 12,900°K. For normal C, N, and O abundances, the He^- and the He I absorptions appear to be the most important absorption mechanisms for very low hydrogen abundances. Hγ becomes weakened for hydrogen abundances less than 0.85×10^{-2} by numbers of atoms. The metal line intensities increase. The colors of extreme helium stars are somewhat redder than for normal stars. The helium convection zone becomes important for the stars with $T_{eff} >$ 9900°K. (auth)

4953 HELIUM CONTENT OF SUBDWARFS. Strom, S. E. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.); Strom, K. M. Astrophys. J., 150: 501-11(Nov. 1967).

The locations of 62 field subdwarfs in the theoretical H–R diagram were determined through a combination of the best available parallax data and a calibration of the relation between corrected $(B-V)_c$ and T_{eff}. A direct determination of T_{eff} for the subdwarfs was accomplished by means of a comparison of spectrum scans covering the wavelength region λλ5000 to 7500 Å with the fluxes predicted from model atmospheres. Values of T_{eff} were determined for stars having a wide range of ultraviolet excesses, δ(U–B), and $(B-V)_{obs}$, and these values allowed a calibration of the T_{eff} -$(B-V)_c$ relation. From the position of the subdwarfs in the H–R diagram relative both to the Hyades and to mild Population II and old Population I field stars, a range of possible helium abundances Y was deduced by use of homology relations based on recent interior calculations. A discussion of the permissible values of Y all but rules out Y = 0 as a choice for the initial galactic helium content. Moreover, no conclusive evidence is found that would suggest a correlation between the metal-to-hydrogen ratio and the helium content. (auth)

4954 EFFECTIVE TEMPERATURES AND GRAVITIES OF LAMBDA BOOTIS STARS. Oke, J. B. (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 150: 513-19(Nov. 1967).

Photoelectric spectrophotometric observations and Hγ profiles were used to determine effective temperatures and gravities of the known λ Bootis stars. Two of these stars, γ Aqr and θ Hya, have energy distributions which indicate that they are double stars in which the secondary component contributes a significant fraction of the light. All stars, apart from 2 And, are near or slightly above the initial main sequence and the values of log g are similar to those of stars on the initial main sequence or the brightest stars in the Hyades. The star 2 And has an abnormally small value of log g and also appears to be substantially below the main sequence. (auth)

4955 ENERGY DISTRIBUTIONS OF G AND K DWARFS AT RED WAVELENGTHS. Whiteoak, John B. (CSIRO, Sydney). Astrophys. J., 150: 521-7(Nov. 1967).

The energy distributions between $1/\lambda(\mu) = 2.018$ and 0.950 were determined for 52 dwarfs and subdwarfs with spectral types ranging from G5 to K7. For each star, intensities were obtained for 16 spectral regions 50 Å wide that were selected on the basis of low-line absorption. The observations were carried out with a photoelectric spectrum scanner. In addition to the overlapping of blue P–V colors from one spectral subtype to another, an effect noted by O. C. Wilson, there is also an overlapping of temperatures as defined by the red energy continua. Except for several stars considered to have unusual energy distributions, it is concluded that the overlapping is due to temperature variations within each spectral group together with differences of abundances or small-scale turbulence in the stellar atmospheres. (auth)

4956 SPECTROSCOPIC OBSERVATIONS OF VV CEPHEI IN THE PHOTOGRAPHIC INFRARED. Glebocki, R.; Keenan, P. C. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware). Astrophys. J., 150: 529-34(Nov. 1967).

The lines of O I at 7774 and 8446 Å, which had been first seen in the spectrum of VV Cep in 1944 and had disappeared in 1945, reappeared in 1964 and persisted until the spring or summer of 1965. Since both apparitions of these strong absorptions coincided with predicted times of secondary minima, it is likely that they arise from a cloud of oxygen gas, probably surrounding the early-type component, which produces absorption when in front of the large M-type component. Although velocities are difficult to measure for these blended lines, the measurements on most of our spectrograms do not indicate strong stream motions for the oxygen atoms. Only in October–November, 1944, was there evidence of oxygen outflow at 15 to 20 km/sec. (auth)

4957 MASS LOSS FROM THREE OB SUPERGIANTS IN ORION. Morton, Donald C. (Princeton Univ., N. J.). Astrophys. J., 150: 535-42(Nov. 1967).

Resonance absorption lines of C IV, N V, and Si IV have been found in the ultraviolet spectra of the OB supergiants δ, ε, and ζ Orionis. The lines are shifted toward shorter wavelengths by ~1400 km sec^{-1}, indicating high-velocity mass ejection. The N V and Si IV lines are sufficiently unsaturated that Doppler velocities and column densities can be determined from the central depths and equivalent widths. A simple model is adopted in which the lines are

formed in a region of constant velocity, and the ionization results from the dilute radiation of the star. The observed ion densities, along with reasonable assumptions for the electron temperature and stellar radius, fix the state of ionization in the shell and the rate of mass loss, which is found to be about 1×10^{-6} $M_\odot$ yr^{-1} for each star. These stars have masses around 30 $M_\odot$ and spend some 6×10^5 yr as blue supergiants so that a few percent of their mass could be ejected. (auth)

4958 THE PECULIAR SPECTRUM OF THE S STAR V 372 MONOCEROTIS. Stephenson, C. B. (Case Inst. of Tech., Cleveland). Astrophys. J., 150: 543-6(Nov. 1967).

Earlier objective-prism evidence that V 372 Mon ($\alpha = 6^h36^m5$, $\delta = -4°30'(1900)$; $m_{pg} = 12.5 - 13.8$) is an S star with exceptionally strong cyanogen bands is confirmed by recent slit spectrograms. It is pointed out that the violet spectral regions of such stars and of N stars seem similarly affected by high continuous opacity, and that it therefore may be doubted that the C_2 molecule is the sole source of this opacity. Low-dispersion spectroscopic observations of other stars similar to V 372 Mon are briefly discussed. (auth)

4959 A STATISTICAL INVESTIGATION OF THE ORIENTATION OF MAGNETIC AXES IN THE PERIODIC MAGNETIC VARIABLES. Preston, George W. (Univ. of California, Santa Cruz). Astrophys. J., 150: 547-50(Nov. 1967).

A statistical method for determining the orientation of magnetic axes of symmetry for the periodic magnetic stars on the assumption that they are oblique dipole rotators leads to a large value for the characteristic magnetic inclination. This result can be constructed to mean that the regions of maximum magnetic intensity are located near the rotational equator whether or not the magnetic field is dipolar. (auth)

4960 STUDIES OF STELLAR ROTATION. V. THE DEPENDENCE OF ROTATION ON AGE AMONG SOLAR-TYPE STARS. Kraft, Robert P. (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 150: 551-70(Nov. 1967).

The rotational velocities of a large sample of field stars with spectral types between F2 IV, V and G3 IV, V have been obtained from coudé spectrograms of resolution about 6 km/sec. It is shown that the average rotational velocity is higher among those with Ca II emission than among those without. Since there is strong evidence that stars with Ca II emission are younger, on the average, than most solar-type stars, a picture is advanced in which rotation declines with advancing age. It is proposed that magnetically coupled winds, similar to the solar wind, are responsible for this deceleration even after a star takes up residence on the main sequence. The winds are presumably generated only in stars which have subsurface hydrogen convection zones and concomitant chromospheres. Estimates of rotational velocity among solar-type stars in the Hyades and Pleiades are given which confirm this general picture. It is shown that the mean rotation in the Pleiades is highest of all groups considered and averages about 40 km/sec for stars of mass 1.20 $M_\odot$. The time scale for reduction by a factor of 2 of the rotational velocities of Pleiades stars is equal to the age of the Hyades, about 4×10^8 years. (auth)

4961 DIFFERENTIAL ROTATION IN STARS. Goldreich, Peter (California Inst. of Tech., Pasadena); Schubert, Gerald. Astrophys. J., 150: 571-87(Nov. 1967).

The stability of differential rotation in the radiative zones of stars is investigated. For sufficiently large χ/ν (χ is the thermal diffusivity and ν the kinematic viscosity), it is shown that a necessary condition for stability in regions of homogeneous chemical composition is that the angular momentum per unit mass be an increasing function of distance from the rotation axis. In cylindrical coordinates (ϖ, φ, z), this condition is given by $\partial(\varpi^2\Omega)/\partial\varpi \geq 0$ and $\partial\Omega/\partial z = 0$, where Ω is the angular velocity. The condition is also a sufficient one when applied to axisymmetric perturbations. The stable thermal stratification which exists in the radiative zone cannot prevent the instability since, in stars, the thermal diffusivity is much greater than the kinematic viscosity. The turbulent diffusion of angular momentum, which arises when the stability condition is violated, is so rapid that it would appear to preclude the fast rotation of the Sun's interior which has been proposed by Dicke. In the absence of the instability associated with thermal diffusion, i.e., if $\chi = 0$, Dicke's solar model is found to be stable. Another means whereby angular momentum might be brought up from the solar interior is by the mechanism of spin-down associated with the formation of an Ekman boundary layer just below the solar convective envelope. The transport of angular momentum, either by spin-down or by turbulent diffusion, would result in the mixing of material below the convective zone of solar type stars if an external torque were applied to the stellar surface. Thus, the depletion of lithium and beryllium would be an inevitable consequence of the loss of a significant fraction of the star's initial angular momentum. (auth)

4962 SPECTROPHOTOMETRIC STUDY OF THE SUPERNOVA THAT APPEARED IN 1967 IN NGC 3389. Andrillat, Yvette (Faculte des Sciences, Montpellier, France). Compt. Rend., Ser. A and B, 265: 430-3(Aug. 16, 1967). (In French).

The spectrum of the supernova Chaudze–Lovas shows large brilliant bands separated by minima. The study of the spectral energy distribution confirms the very low emission in the ultraviolet expected in supernova of type I. (tr-auth)

4963 HIGH-VELOCITY CONTACT BINARY. Eggen, O. J. (Australian National Univ., Canberra). Astrophys. J., 150: L111-12(Nov. 1967).

The large proper-motion object G29–37 is a light-variable with a period of $0^d.26$ and photometric characteristics of a contact binary. (auth)

4964 RU CAM: EARLY PHASES OF RECOVERY. Fernie, J. D.; Watt, Vicki (Univ. of Toronto). Astrophys. J., 150: L113-15(Nov. 1967).

RU Cam is a peculiar Population-II Cepheid that was found by Demers and Fernie (1966) to have practically stopped pulsating in late 1965, early 1966. Photometric results for this star that have been obtained at the David Dunlap Observatory, subsequent to those published by Demers and Fernie, are discussed. It is pointed out that these observations indicate that RU Cam is now in a stage of recovering its pulsation. (W.D.M.)

4965 THE SIZE OF JUPITER'S DECAMETRIC RADIO SOURCE. Dulk, G. (Univ. of Colorado, Boulder); Rayhrer, B.; Lawrence, R. Astrophys. J., 150: L117-20(Nov. 1967).

Observations of 34-MHz radio emission from Jupiter, made with an intensity interferometer having a spacing of 175 km (19,800 wavelengths), indicate that both the long pulses and the millisecond-burst fine structure emanate from regions smaller than 3". (auth)

4966 A LOWER LIMIT ON THE $^{12}C/^{13}C$ RATIO IN THE INTERSTELLAR GAS. Augason, G. C. (Ames Research Center, Moffett Field, Calif.); Herbig, G. H. Astrophys. J., 150: 729-30(Nov. 1967).

A lower limit for the abundance ratio $a = N(^{12}C)/N(^{13}C) \geq 30$ was established for the interstellar molecules seen in the direction of ζ Oph. This value of a is compared with that for ^{13}C-rich carbon stars and its implication with respect to interstellar matter is discussed. (auth)

4967 LITHIUM ABUNDANCES IN THE PLEIADES AND URSA MAJOR CLUSTERS. Danziger, I. J. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 150: 733-5 (Nov. 1967).

Determinations of lithium abundances in main-sequence stars of the Pleiades, and the Ursa Major nucleus clusters are presented. Some implications concerning the time scales for depletion of lithium are discussed. (auth)

4968 POSITIONS OF QUASI-STELLAR OBJECTS AND RADIO GALAXIES. Lu, Phillip K.; Frederick, Laurence W. (Univ. of Virginia, Charlottesville). Astrophys. J., 150: L71-3(Nov. 1967).

A program of long-focus astrometric plates of quasars and highly condensed radio galaxies was begun in June 1966. The purposes of the program were to provide accurate positions and to serve as reference frame standards for the McCormick proper-motion studies in high-galactic latitude regions in the future. (W.D.M.)

4969 THE DISTRIBUTION OF GALACTIC X-RAY SOURCES FROM SCORPIO TO CYGNUS. Gursky, H.; Gorenstein, P.; Giacconi, R. (American Science and Engineering, Cambridge, Mass.). Astrophys. J., 150: L75-84(Nov. 1967).

The objective of the present survey was to establish the position of galactic sources between $l^{II} = -15°$ and $l^{II} = +90°$ with a higher precision and sensitivity than had been previously obtained and to measure the energy spectrum of the x rays from the stronger sources. The survey was accomplished during a rocket flight on Oct. 11, 1966. (W.D.M.)

4970 ON THE BINARY NATURE OF CYG X-2. Burbridge, E. M.; Lynds, C. R.; Stockton, A. N. (Univ. of California, Los Angeles, Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 150: L95-7(Nov. 1967).

A spectrogram of Cyg X-2 was obtained on July 2, 1967, at Lick with the conventional prime-focus spectrograph and solid Schmidt camera on the 120-inch telescope. While the spectral features were similar in intensity and width to their appearance on June 9, it was found that there had been a large change in velocity, with the absorption lines yielding an average value of –96 km/sec and

the He II λ4686 emission line giving −410 km/sec. This reversal in absorption- and emission-line velocities suggested that the object might be a spectroscopic binary viewed from a direction in or near the orbital plane. (W.D.M.)

4971 RAPID PHOTOMETRIC AND SPECTROSCOPIC VARIATIONS OF THE X-RAY SOURCE CYG X-2. Kristian, Jerome; Sandage, Allan; Westphal, J. A. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 150: L99-105(Nov. 1967).

Fluctuations of 0.04 mag on a time scale of minutes have been found in the optical flux of the candidate star for Cyg X-2. Comparison of radial velocities on a well-widened spectrogram with those of Lynds shows large changes, confirming an earlier suspicion of binary motion by E. M. Burbidge. The systemic velocity is $\gamma = -250$ km/sec. A lower limit of 300 km/sec for the orbital velocity of one component relative to the other is indicated. The system parameters are $m_1/m_2 = 1$, $P < 0.4\ m\odot$ (days), and $a < 0.01\ m\odot$ A.U., indicative of a very close binary system ($m = m_1 + m_2$). Eclipses are probable and may have been observed. Spectroscopic evidence may be present for gas streams moving with speeds of greater than 700 km/sec. Three independent arguments are given why the optical flux cannot primarily be nonthermal radiation connected with the production of the x rays. (auth)

4972 A CRITICAL TEST OF THE ELECTRICAL DISCHARGE MODEL OF THE VENUS MICROWAVE EMISSION. Pollack, James B.; Sagan, Carl (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 150: 699-706(Nov. 1967).

It has been suggested that electrical discharges between adjacent cloud particles are responsible for the Venus microwave emission. The predicted variation of brightness temperature with angular distance from the planetary limb is calculated for this model. The discharging layer will be limb-brightened, but the thermal emission from the underlying surface and atmosphere will be limb-darkened. The net limb effects are calculated for a variety of opacity sources, surface dielectric constants, surface temperature distributions, surface roughnesses, positional variations in the temperature of the discharging layer, and other variables. In all cases the predictions are inconsistent with the most reliable fraction (the peak temperatures in each scan for the 19 millimeter channel) of the Mariner 2 microwave data set. On the other hand, the hot surface model is consistent with the same data. (auth)

4973 HIGH-LATITUDE PLANETARY NEBULA. Arp, Halton; Scargle, Jeffrey D. (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 150: 707-9(Nov. 1967).

A blue star imbedded in faint nebulosity has been discovered at high galactic latitude. Spectra photoelectric photometry, and interference-filter photography show that it is a member of the class of old planetary nebulae. Radial velocities and proper motions enable a distance to be estimated. (auth)

4974 A DISTANCE LIMIT FOR THE QUASI-STELLAR OBJECT 3C 147. Shuter, W. L. H.; Pulley, H. C.; Rogstad, D. H. (Univ. of British Columbia, Vancouver. California Inst. of Tech., Pasadena). Contract N00014-67-A-0094-0008. Astrophys. J., 150: 711-13(Nov. 1967).

Since current theories suggest that the observed red shifts of quasars may not be a reliable indication of their distance, it has appeared desirable to investigate other methods of estimating or setting limits to their distances. The technique described uses the spiral arms of the Milky Way as distance indicators. If a quasar is beyond a galactic arm, its continuous rf spectrum should show appreciable 21-cm absorption at the frequency at which the arm normally emits 21-cm line radiation. Thus, the 21-cm spectrum of 3C 147 indicates clear absorption in the local arm, and also in the Perseus arm, indicating that 3C 147 is at a distance $r \geq 1.1$ kpc. There is also a strong indication from the spectrum that 3C 147 is beyond 9.2 kpc, which would place it at the edge of, or beyond, the galactic disk. (W.D.M.)

4975 RADIO RECOMBINATION LINES AND ANOMALOUS BALMER LINE INTENSITIES. Kaler, James B.; Lee, Paul D. (Univ. of Illinois, Urbana). Astrophys. J., 150: 715-19(Nov. 1967).

Two problems concerning hydrogen recombination in gaseous nebulae are discussed, and it found that (1) there is good correlation between the optically observed hydrogen and helium line intensity anomalies and the Doppler temperature measured from line width; and (2) a similar correlation exists between the electron temperatures of diffuse nebulae, as measured by radio recombination lines, and the Doppler temperature. (W.D.M.)

4976 RECENT NEUTRON-CAPTURE DATA AT STELLAR TEMPERATURES. Macklin, R. L.; Gibbons, J. H. (Oak Ridge National Lab., Tenn.). Astrophys. J., 150: 721-2(Nov. 1967).

Neutron capture cross sections averaged over Maxwell–Boltzmann temperature distributions appropriate to stellar interiors are presented. Recent data on Eu and isotopes of Te, Lu, and Pb permit calculations for kT from 30 to 90 keV. (auth)

4977 DEPENDENCE OF THE ^{8}B SOLAR NEUTRINO FLUX ON HEAVY ELEMENT COMPOSITION. Bahcall, John N.; Cooper, Martin; Demarque, Pierre (California Inst. of Tech., Pasadena. Univ. of Chicago). Astrophys. J., 150: 723-4(Nov. 1967).

An estimate is made of the uncertainty in the predicted ^{8}B solar neutrino flux due to the uncertainty in the primordial composition. (W.D.M.)

4978 NON-RADIAL OSCILLATIONS AND THE BETA CANIS MAJORIS STARS. II. THE EFFECT OF DIFFERENTIAL ROTATION. Clement, Maurice J. (National Research Council, Ottawa). Astrophys. J., 150: 589-605(Nov. 1967).

The hypothesis that the beat phenomenon of the β Canis Majoris stars is the result of a coupling in the presence of rotation of the radial and the second harmonic modes of oscillation is re-examined to determine the effect of nonuniform rotation. It is shown that the particular form of differential rotation used here removes the discrepancy that exists between the observations and earlier calculations based on the assumption of uniform rotation. (auth)

4979 SPECTRAL LINE FORMATION IN VARIABLE-PROPERTY MEDIA: THE RICCATI METHOD. Rybicki, G. B. (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Hummer, D. G. Astrophys. J., 150: 607-35(Nov. 1967).

A numerical method, based on a generalized Riccati transformation of Rybicki and Usher, is presented for the integration of the radiative transfer equation for spectral line formation by noncoherent scattering in inhomogeneous plane-parallel media. A model atom with two discrete levels is assumed. An asymptotic theory is developed which permits the application of this method to problems involving semi-infinite media. Numerical results obtained by the Riccati method are used to discuss the effects of spatial variations in the Doppler width on lines formed by pure Doppler broadening. (auth)

4980 DEPARTURES FROM LTE IN G- AND K-STAR ATMOSPHERES. Strom, S. E. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 150: 637-45(Nov. 1967).

A series of non-LTE model atmospheres in the range $4000° < T_{eff} < 6000°$K with $\log g = 2$ and 4.44 was computed. In the calculation of these models, the equations of statistical equilibrium for H^- and the first three levels of atomic hydrogen and the equations of radiative transfer and hydrostatic equilibrium were solved simultaneously. The computed temperature–pressure relationships and the emergent fluxes are found to be sensitive to the choice of the reaction rate, C_-, for associative detachment of H^-. The effects of the computed departures from LTE on solar limb darkening and stellar fluxes suggest several observational tests for detecting the departures. One of these tests, for which the requisite data are available, indicates that the atmospheres of late G and early K giants may be affected significantly by deviations from LTE. (auth)

4981 POLARIZATION OF RADIO SOURCES. I. HOMOGENEOUS SOURCE OF ARBITRARY OPTICAL THICKNESS. Pacholczyk, A. G.; Swihart, T. L. (Univ. of Arizona, Tucson). Astrophys. J., 150: 647-50(Nov. 1967).

Solutions of the equation of transfer are obtained, and the degree of polarization is derived for a homogeneous source in which polarized emission, polarized absorption, and Faraday rotation are included. Only optically thin cases have been considered in previous works, and the present equations show how the polarization is influenced by absorption. Polarization measurements may help to determine whether synchrotron self-absorption, thermal absorption, or another process is responsible for the curvature in the spectra of certain radio sources at the low frequencies in which absorption is thought to be important. (auth)

4982 NON-RELATIVISTIC EQUATIONS OF BULK MOTION OF A RELATIVISTIC GAS. II. ELECTROMAGNETIC EFFECTS AND SUPRATHERMAL WAVES. Lerche, I. (Univ. of Chicago). Astrophys. J., 150: 651-65(Nov. 1967).

The equations of bulk motion of a gas, in which the pressure cannot be neglected compared to the rest energy of the gas, are deduced by taking moments of the collisionless Boltzmann equation including electromagnetic terms. To order u^2/c^2, where u is the bulk velocity, the derived equations agree with the usual relativistic equations of motion of an ideal fluid. The present analysis relates the mass density and the pressure tensor directly, in terms of integrals over the particles' motions, whereas the standard deri-

vation in terms of the divergence of an energy–stress tensor does not relate the mass density and pressure tensor to the microscopic properties of the fluid. For a particularly simple situation a linearized perturbation analysis yields the modes of oscillation of the gas. An elementary study is made of waves propagating parallel and perpendicular to an ambient magnetic field. It is demonstrated that the modes of oscillation differ markedly from those obtained for a nonrelativistic gas. The problem is of interest because of its application to the cosmic-ray gas in the Galaxy, nonthermal radio sources emitting radiation by the synchrotron mechanism, and possibly fluctuations in quasi-stellar objects brought about by relativistic particles. (auth)

4983 THE SOLAR DISK SPECTRUM NEAR 6708 Å. Daehler, Mark (Univ. of Wisconsin, Madison. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 150: 667-74(Nov. 1967).

The spectrum of the solar disk in the region of the lithium resonance lines (6708 Å) was measured with a resolution of 3×10^5 and high photometric precision (about 0.014% of the continuum), using the solar image formed by the McMath solar telescope at Kitt Peak National Observatory and the Pepsios spectrometer, a pressure-scanned instrument whose dispersive elements consist of an interference filter and three Fabry–Perot interferometers. The profile of the very weak lines observed (having central depths of about 1 per cent of the continuum) is difficult to explain on the basis of lithium absorption. A computer program was used to decompose the observed absorption into a sum of Gaussians, with the result that the observed spectrum in the region of the lithium lines can be fitted very easily by two non-lithium lines, but only with great difficulty with the lithium profile. The conclusion is that there is no evidence for the existence of lithium in the solar atmosphere from the Fraunhofer spectrum of the disk. (auth)

4984 FLUORESCENT RAYS OF O III IN THE SPECTRUM OF THE NUCLEUS OF THE GALAXY NGC4151. Andrillat, Yvette; Souffrin, Suzanne (Faculte des Sciences, Montpillier, France). Compt. Rend., Ser. A and B, 265: 374-7(Aug. 1967). (In French).

The presence in the ultraviolet spectrum of NGC4151 of fluorescent rays of O III coming from the $3d^3P_2^0$ term shows the identity of excitation mechanism with planetary nebula and the absence of turbulence in the region where the forbidden rays are formed. (tr-auth)

4985 SPACE WEATHERING OF LUNAR AND ASTEROIDAL SURFACES. Zeller, Edward J. (Univ. of Kansas, Lawrence); Ronca, Luciano B. Icarus, 7: 372-9(Nov. 1967).

Exposure to the solar wind and solar cosmic rays for long periods of time may cause substantial alterations in the geochemistry of the target material. Experimental results indicate that hydration of oxygen-rich materials can be expected in any surfaces which are exposed to solar protons. Furthermore, surfaces which are undergoing little erosion and no churning may develop a chemical stratification consisting of a thin upper layer of chemically reduced material overlying the thicker hydrated zone. For bodies unprotected by magnetic fields, hydration of all unit cells to a depth of 10^{-3} cm may be achieved in 10^6 to 10^7 years. Increased erosional rates would proportionately decrease the amount of hydration. In the case of surface materials undergoing churning, the amount of weathering and erosion is a function of the depth and rate of churning. If Shoemaker's deductions are correct, that is, one turnover of the uppermost millimeter every 10 to 100 years, the hydration of the upper millimeter could be considerable for particles of less than 10^{-3} cm in diameter. (auth)

4986 EXPERIMENTAL RESULTS FROM MEASUREMENTS PERFORMED DURING THE NOVEMBER 12, 1966 TOTAL SOLAR ECLIPSE WITH A 4.28-cm RADIO POLARIMETER. Kaufmann, Pierre; Matsuura, Oscar T.; Marques dos Santos, P. (Mackenzie Univ., Sao Paulo, Brazil. Inst. for Studies of Electromagnetic Phenomena, Sao Paulo, Brazil). Icarus, 7: 380-6(Nov. 1967).

Radio observations of the Sun with a 4.28-cm radio polarimeter were performed during the November 12, 1966 total solar eclipse at a site located near the city of Bagé, in the extreme south of Brazil. The solar activity during that period is discussed, giving additional data for the eclipse measurements themselves. The difference between radio and optical contacts indicated that there is a significant radio emission at a height near 0.12 solar radii over the photosphere, and the basic residual flux due to the contribution of the ring during the totality was found to be 12.2% of the total flux. An important "radio spot" was present near the center of the solar disk, contributing almost alone to the observed basic left-handed circularly polarized component of solar radiation. During totality no important residual polarization was found and if it still existed it is negligible. (auth)

4987 CONTINUOUS CREATION IN A CLOSED WORLD MODEL. Nachtmann, Otto (Univ. of Vienna). Z. Phys., 208: No. 2, 113-15(1968).

It is shown that spontaneous creation can occur in de Sitter space of positive curvature. The rate, however, is extremely low at the present stage of the universe. (auth)

4988 THE SPECTRA OF SEVERAL X-RAY SOURCES IN CYGNUS AND SCORPIO. Gorenstein, P.; Giacconi, R.; Gursky, H. (American Science and Engineering, Cambridge, Mass.). Astrophys. J., 150/ L85-94(Nov. 1967).

The spectra of several x-ray sources that were observed during a sounding rocket flight on Oct. 11, 1966, described in the preceding paper, are analyzed. These include the three strongest sources in Cygnus and six at low galactic longitude. The results indicate that the spectra exhibit variations in their degree of hardness and in their behavior at the low-energy end. (W.D.M.)

4989 LIGHT VARIATIONS OF THE SEYFERT GALAXY NGC 4151. Fitch, W. S.; Pacholczyk, A. G.; Weymann, R. J. (Univ. of Arizona, Tucson). Astrophys. J., 150: L67-70(Nov. 1967).

In the spring of 1967 the Seyfert galaxy NGC 4151 was measured photoelectrically in the U, B, V, and K passbands. The UBV measurements were carried out with the 36-inch reflector of the Steward Observatory at Kitt Peak using a standard single-channel photometer and reduced using a computer program. The infrared K measurements were made with Johnson's JKL photometer attached to the 60-inch reflector at Mount Lemmon. (W.D.M.)

4990 ENERGY TRANSFER VIA GRAVITATIONAL RADIATION IN THE QUASISTELLAR SOURCES. Cooperstock, Fred I. (Dublin Inst. for Advanced Studies). Phys. Rev., 163: 1368-73 (Nov. 25, 1967).

A more precise, detailed analysis of the mechanism of energy transfer via gravitational radiation in Fowler's model of the quasistellar sources is presented. To ascertain the upper limit for efficiency, the resonant energy transfer for vibrational and rotational modes of the envelope is computed. In the vibrational mode, the energy transfer is maximal for vibrations perpendicular to the spin axis of the core. For nonresonant gravitational interaction, accelerations acquired by particles on the polar axis and in the spin plane of the core are computed. The latter accelerations dominate for all but ultrarelativistic particles. The calculations do not appear to favor Fowler's proposed polar explosion. (auth)

4991 THE SOLAR X-RAY FLARE OF JULY 7, 1966. Van Allen, J. A. (Univ. of Iowa, Iowa City). Contracts NAS5-9076; Nonr-1509(06). J. Geophys. Res., 72: 5903-11(Dec. 1, 1967).

By means of a mica window Geiger–Mueller tube on Earth satellite Explorer 33, a major solar x-ray flare was observed with 81.8-sec time resolution on July 7, 1966. The flare had its onset at 0023, its maximum intensity at 0042, and a total duration of about 200 minutes. The maximum energy flux was 3×10^{-2} erg/cm^2 sec, and the time-integrated flux was 97 erg/cm^2 ($2 < \lambda < 12$ A). Assuming equal intensity over 2π steradians at the Sun, the total emission in this wavelength band was 1.4×10^{29} ergs, and the maximum surface luminosity of the Sun was 2.9×10^6 erg/cm^2 sec or 4.5×10^{-5} of the whole radiant luminosity of the average solar surface. Charged particles began to arrive at the satellite at 0058, or 35 minutes after the first detection of the x-ray enhancement, and remained in the interplanetary system for at least ten days thereafter. The intensity–time curve of the soft x rays is compared with those of 2700-Mhz solar radio noise flux and of ionospheric absorption at 22 Mhz as observed at Penticton. (auth)

4992 X-RAY STARS. Giacconi, Riccardo. Sci. Amer., 217: No. 6, 36-46(Dec. 1967).

A general review is given on the detection of x radiation from interstellar space and experiments and instrumentation designed to pinpoint strong sources of x rays are described. Work leading up to the discovery of Sco X-1 is reviewed and the future of x-ray astronomy is discussed. (W.D.M.)

4993 HISTORY OF THE UNIVERSE. Gamow, George (Univ. of Colorado, Boulder). Science, 158: 766-9(Nov. 10, 1967).

The purpose of this paper is to give the general description of the time-depending, uniformly curved space and to compare it with the available information. The paper is accompanied by two more recent letters. (W.D.M.)

4994 FIRST RESULTS OF THE MEASUREMENT OF THE ABSORPTION BY THE TERRESTRIAL ATMOSPHERE AND THE BRIGHTNESS TEMPERATURE OF THE SOLAR LINE AT 5.65 MM WAVE LENGTH. Gautier, D. (CNET, Issy-les-Moulineaux,

France); Renan, J.-P. Ann. Astrophys., 30: 739-44(July-Aug. 1967). (In French).

A series of radiometric experiments on millimetric waves was carried out in order to determine the absorption by the terrestrial atmosphere and the brightness temperature of the solar line at 5.65-mm wave length. The radiometric device used was composed of a radiometer and an antenna of the Cassegrain type. The measurement procedures used are outlined. The first measurement gave for the total vertical attenuation at 53 GHz a mean value of 4 dB and a brightness temperature of approximately 7,000°K. (J.S.R.)

4995 ^{244}Pu IN THE EARLY SOLAR SYSTEM AND CONCORDANT PLUTONIUM/XENON AND IODINE/XENON DECAY INTERVALS OF ACHONDRITES. Sabu, D. D.; Kuroda, P. K. (Univ. of Arkansas, Fayettesville). Nature (London), 216: 442-6(Nov. 4, 1967).

Concordant plutonium/xenon and iodine/xenon decay intervals have been obtained for a dozen meteorites, mostly achondrites. Plutonium-244 and iodine-129 abundances in the early solar system suggest that these extinct nuclides were synthesized in the galactic nucleo-synthesis process, which lasted several billion years. (auth)

4996 EVIDENCE OF CONTINUUM EMISSION FROM JUPITER AT 18 Mc. Barrow, C. H.; Williams, J. R. (Florida State Univ., Tallahassee). Nature (London), 216: 462-3(Nov. 4, 1967).

It was reported earlier that almost continuous "bursty" radiation from Jupiter could be detected at low frequencies if an aerial-receiver system of sufficient sensitivity was available. A marked increase in emission probability at 26.3 Mc was also found using the large array at Clark Lake Radio Observatory. Evidence is presented in this communication of a related effect at 18 Mc observed on several occasions during the 1966–67 apparition of Jupiter; this refers to a relatively steady emission, sometimes appearing as a background to the more usual "bursty" type of emission. The observations were made with an interferometer consisting of two identical broadside arrays, each consisting of four whole-wave dipoles, on an E–W baseline of 16 wavelengths. The event characteristics are tabulated. A total of 17 events out of 43 observed during the period November 5, 1966 to March 4, 1967 contained evidence of continuum emission. That this effect was not observed on every occasion presumably indicates that the continuum emission is either not a frequent occurrence at 18 Mc, or that it is always present but usually of too low intensity to be recorded. (UK)

4997 CASE OF THE VANISHED CORRELATION IN STATISTICS OF QUASI-STELLAR OBJECTS. Gamow, G. (Univ. of Colorado, Boulder). Nature (London), 216: 461-2(Nov. 4, 1967).

The result of the studies by Longair and Scheuer (Nature 215: 919 (1967)) concerning the possible correlation between optical and radio intensities and red shifts in quasars are discussed. These authors found that correlation disappeared when the effects of relativistic time dilation were eliminated. An explanation of this disappearance is offered, based on absorption by galaxies. The observed Doppler effect in the absorption lines will correspond not to the recession velocity of the source, but to that of an intervening galaxy. (UK)

4998 SPECTRA OF SOME BLUE OBJECTS IN HIGH GALACTIC LATITUDES. Dibai, E. A.; Esipov, V. F. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 220-3(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 278-82(Mar.-Apr. 1967).

A search was made for extragalactic objects among blue stars in high galactic latitudes. Spectra of Tonantzintla objects 256, 259, 261, 262, 264, 266, 788, 811, 812, and 817 were obtained with an image tube and a grating spectrograph at the Cassegrain focus of the 125-cm reflector. Except for Ton 256, none of the objects exhibits emission lines. A spectrophotometric study was made of the quasi-stellar galaxy Ton 256, discovered by Sandage. The physical parameters of the gaseous envelope are derived from the forbidden-line intensities. The situation is found to be similar to the phenomena observed in Seyfert galaxy nuclei, but on a larger scale. (auth)

4999 POSSIBLE POLARIZATION OF BREMSSTRAHLUNG X RADIATION FROM SOLAR FLARES. Korchak, A. A.; Leontovich, M. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radiowave Propagation, Moscow). Dokl. Akad. Nauk SSSR, 173: 291-4(Mar. 11, 1967). (In Russian).

An examination is presented of the method of analyzing the polarization of hard solar-flare x radiation in order to determine the radiation generation mechanism involved (bremsstrahlung, synchrotron, Compton). Specifically, Dolan's (Astr. Phys. J., 70: 137(1965)) conclusion that the detected linear polarization signifies either that the x radiation is synchrotron radiation or, if the angular distribution of radiating electrons is anisotropic, that it is bremsstrahlung radiation, is examined. The second possibility namely, bremsstrahlung, is analyzed in greater detail inasmuch as the generation of sharply anisotropic accelerated electron beams would be most probable in the case of solar flares. Bremsstrahlung polarization properties are analyzed both for the case of a parallel electron beam as well as the case where the electrons are captured in the magnetic field and an angular velocity distribution is established. It is concluded that if the energy spectrum of electrons accelerated in a flare extends into the nonrelativistic region, the bremsstrahlung will significantly exceed both the Compton and synchrotron radiation. The degree to which x radiation will be linearly polarized depends on the frequency. For best results in determining the radiation mechanism in polarization observations, it is recommended that the observations be conducted in at least two photon energy regions which are relatively distant from each other in terms of the energy spectrum. (ATD)

5000 ON THE NATURE OF THE INFRARED NEBULA IN ORION. Hartmann, William K. (Univ. of Arizona, Tucson). Astrophys. J., 149: L87-90(Sept. 1967).

A recently discovered infrared nebula in Orion is interpreted as a proto-cluster with 1 to 10^2 massive stars imbedded in an opaque dust cloud. Collapse is about to be or has been reversed, and lifetimes of such objects in the observed states are expected to run 2 to 10×10^5 years. (auth)

5001 NEGATIVE RESULTS IN A SEARCH FOR RADIO EMISSION FROM INFRARED AND T TAURI STARS. Comella, J. (Cornell Univ., Arecibo, Puerto Rico). Astrophys. J., 149: L91-2(Sept. 1967).

Negative results were obtained in a search for radio emission from the following infrared and T Tauri stars: two objects in Cygnus and Taurus, T Tau, RY Tau, and R Mon. The 1950.0 coordinates, frequencies of observation, and numbers of observations at each frequency for each are tabulated. All the observations were made with the Arecibo 1000-ft telescope and Dicke-switched radiometers. (W.D.M.)

5002 INFRARED RADIATION FROM UPSILON SAGITTARII. Lee, Thomas A.; Nariai, Kyoji (Univ. of Arizona, Tucson. Tokyo Astronomical Observatory, Mitaka). Astrophys. J., 149: L93-5(Sept. 1967).

Infrared photometry of υ Sgr was undertaken with the hope that it would reveal the nature of the secondary component. The mean magnitude and colors from three UBVRI observations and three JHKL observations are given along with a comparison of the colors of υ Sgr with those of standard stars. (W.D.M.)

5003 INFRARED OBSERVATIONS OF THE PLANETARY NEBULA NGC 7027. Gillett, F. C. (Univ. of California, San Diego); Low, F. J.; Stein, W. A. Astrophys. J., 149: L97-100 (Sept. 1967).

Observations of NGC 7027 were made in May and June 1967, at the Catalina observing station in an attempt to detect an infrared line of S^{+++} at $\lambda = 10.53\ \mu$. As a result of the observations there was some indication of the detection of the predicted line. However it was discovered that there was a measurable continuum flux from NGC 7027 in the wavelength range from 7.5 to 14 μ that compared in value with the strength of stellar radiation from α Lyr(AO) at about 9 μ. (W.D.M.)

5004 OBSERVATIONS OF HZ 29. Wampler, E. Joseph (Univ. of California, Santa Cruz). Astrophys. J., 149: L101-3 (Sept. 1967).

Burbidge, Burbidge, and Hoyle (1967) have argued that HZ 29, considered by Greenstein and Matthews (1957) to be a white dwarf with a helium spectrum, may be a radio-quiet, quasi-stellar object. Recently Smak (1967) has reported that the magnitude of HZ 29 is variable with a period of 18 min and an amplitude of 0.03 mag. In an effort to obtain additional data, photoelectric scans of HZ 29 were obtained using the Lick prime-focus scanner at the 120-in. telescope. (W.D.M.)

5005 PHYSICAL CONDITIONS IN SCO X-1. Tucker, W. H. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 149: L105-9 (Sept. 1967).

Some restrictions on the parameters characterizing Sco X-1 are discussed, and a model for Sco X-1 and other x-ray sources is suggested. The basic assumptions are: (1) the x-ray flux observed in the 2- to 30-keV range is due to bremsstrahlung from an optically thin plasma with a temperature $T = 5 \times 10^{8}$°K, and (2) the gas has the cosmic abundances given by Aller (1961). (W.D.M.)

5006 THE SPECTRA OF OQ208 AND OTHER CENTIMETER WAVELENGTH RADIO SOURCES. Kraus, J. D.; Scheer, D. J. (Ohio State Univ., Columbus). Astrophys. J., 149: L111-13 (Sept. 1967).

In a recent survey at 1415 MHz with the OSU 260-foot telescope a number of relatively strong radio sources were found which do not appear in the 4C survey at 178 MHz. Flux density measurements over a range of frequencies reveal that several of these new sources have very unusual spectra. OQ 208 is of considerable interest because of the possibility that it is a variable quasar. Data on the sources are summarized and the spectra are presented. (W.D.M.)

5007 SPECTROPHOTOMETRIC STUDIES OF THE CHROMOSPHERIC BURST, AUGUST 21, 1959. I. Guseinov, R. E. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk, No. 2, 129-38(1966). (In Russian).

The article is a continuation of the studies of one series of chromosphere flashes observed by the Czechoslovak Observatory using a multi-chamber spectrograph on Aug. 21, 1959, at 16 hr, 12 min, 30 sec−17 hr, 00 min, 00 sec at 7° north latitude and 24° west longitude. A detailed spectrophotometric analysis was made of the three clearly outlined centers of the flash, each of which differs by its electron concentration, electron temperature, etc., due to the heterogeneity of the solar atmosphere. Spectrophotometric studies of the series are discussed according to the contours of the H_α, H_δ, H_γ, and H_ϵ lines using the 136 outlines of the emission and unperturbed atmosphere lines. (tr-auth)

5008 EXTRAGALACTIC RADIOSOURCES. III. QUASI-STELLAR OBJECTS. Rosenberg, J. (Univ., Utrecht). Ned. Tijdschr. Natuurk., 33: 161-92(June 1967). (In Dutch).

Properties of quasars including form, color, dimensions, continuum and line spectra, changes in brightness, and the red shift are reviewed. Radio observations on the identification, form, diameter, and spectral intensity changes are summarized. A correlation between quasars and radio systems was found. Data are interpreted and explanations are given of the following: the red shift, age, size, the optical spectrum, radio spectrum, and energy output. A number of theories, which take into consideration the production of high-energy electrons, are summarized. The cosmological implications of quasars are considered. (57 references) (J.S.R.)

5009 ORIGIN OF HELIUM IN THE UNIVERSE. Ledoux, P. Bull. Cl. Sci., Acad. Roy. Belg. (5), 52: 1613-35(1966). (In French).

The theories on the origin of helium in the Universe are surveyed on the basis of a bibliographic review. The experimental data on which the theories are based are briefly summarized. (36 references) (J.S.R.)

5010 SOLAR SPIN-DOWN PROBLEM. Dicke, R. H. (Princeton Univ., N. J.). Astrophys. J., 149: L121-7(Sept. 1967).

Howard et al. (1967) have suggested that the solar oblateness observed by Dicke and Goldenberg (1967) could not be due to the quadrupole moment produced by a rapidly rotating core in the Sun. They argue that the required differential rotation would be quickly damped through a "spin-down" process involving the localization of the differential rotation in a very thin shell (the Ekman layer) and the "pumping" of the rapidly spinning core through this shell. The author takes exception to this argument and states a doubt that this "spin-down" effect would occur in the Sun. (W.D.M.)

5011 ENERGY DISTRIBUTION IN THE SOLAR ULTRAVIOLET CONTINUUM BETWEEN 1550 AND 2100 A. Sandlin, Glenn D.; Widing, Kenneth G. (Naval Research Lab., Washington, D. C.). Astrophys. J., 149: L129-31(Sept. 1967).

Recent work has emphasized the importance of the solar spectrum between 1525 and 1700 Å for an understanding of the region of the solar temperature minimum. Although calibrated continuum intensities have been published for the spectrum down to 1750 Å, and for the region below 1510 Å, no calibrated data have been available for the intervening spectral range. New spectra suitable for extensive photometry were obtained on July 27, 1966, by Garrett, Snider, Purcell, and Tousey. These spectra cover the wavelength range 1300 to 2100 Å at a resolution of approximately 0.2 Å. Some preliminary results of photographic photometry of these plates, especially as they relate to the spectral range 1525 to 1700 Å, are presented. (W.D.M.)

5012 METAL DEFICIENCIES VERSUS MICROTURBULENCE AS THE SOURCE OF ULTRAVIOLET EXCESS AND Δm_1 RESIDUALS. McNamara, D. H. (Brigham Young Univ., Provo, Utah). Astrophys. J., 149: L133-9(Sept. 1967).

Conti and Deutsch (1966) have recently presented evidence in favor of the idea that differences in microturbulence are chiefly responsible for the uv excesses and metal residuals, Δm_1, that are found in solar-type disk population stars. This conclusion differs markedly from the widely held view that deficient metal content is the cause of uv excesses and metal residuals. This is discussed briefly and it is concluded the m_1 index is primarily a measure of the metal abundances in solar-type main-sequence stars, and since uv excesses correlate with Δm_1 residuals, the uv excess is also primarily a measure of metal abundance. (W.D.M.)

5013 MERCURY'S MICROWAVE PHASE EFFECT. Gary, Bruce (California Inst. of Tech., Pasadena). Astrophys. J., 149: L141-5(Sept. 1967).

It is pointed out that the recent measurements at λ3.4 mm and λ1.9 cm of the phase effect in Mercury's thermal emission are incompatible with each other when interpreted with a simple model for the thermal behavior of the planet's surface. (W.D.M.)

5014 ANGULAR SIZE OF 3C 273B. Clark, B. G. (National Radio Astronomy Observatory, Green Bank, W. Va.); Cohen, M. H.; Jauncey, D. L. Astrophys. J., 149: L151-2(Sept. 1967).

An independent local oscillator interferometer was operated at a wavelength of 18 cm between Hot Creek and Green Bank. The resulting interferometer has a base line of 1.9×10^7 wavelengths, giving a fringe spacing of 0.01 in. This instrument was used on July 22 to 26, 1967, to observe the radio source 3C 273. From the measurements it is concluded that 3C 273 has a component of angular size less than 0.005 in. (W.D.M.)

5015 FRACTIONATION OF IRON IN THE SOLAR SYSTEM. Banerjee, S. K. (Ampex Corp., Redwood City, Calif.). Nature (London), 216: 781(Nov. 25, 1967).

It has recently been suggested that magnetostatic attraction between cosmic iron particles is responsible for the observed variation in iron abundance between the inner and outer planets of the solar system. It is pointed out, however, that crucial assumption in this is "uniform single-domain nature" of Fe particles in the size range 10^{-4} to 10^{-3} cm, and it is shown that Fe particles of only a limited size range can take part in magnetostatic accretion. (UK)

5016 COSMIC BLACKBODY RADIATION AND ISOTROPIC GAMMA RAYS: A CONTRADICTION. Felten, J. E. (Univ. of California, San Diego). Nature (London), 216: 775-6(Nov. 25, 1967).

Cheng (Nature 215:1035(1967)), in his paper on the isotropic gamma-ray background, presented instructive calculations on the production and propagation of inverse Compton gamma rays in an expanding Universe. The paper, however, gives the impression that there is some conflict between the observed x-ray and gamma-ray background and the blackbody interpretation of the observed microwave background. The purpose of the present communication is to assure "big bang" theorists that this is not the case; to whatever extent the gamma radiation is relevant, its high intensity and steep spectrum tend to favor the blackbody hypothesis. (UK)

5017 BLACKBODY RADIATION AND THE EDDINGTON–LEMAITRE UNIVERSE. Roeder, R. C.; Chambers, R. H. (Univ. of Toronto). Nature (London), 216: 774-5(Nov. 25, 1967).

The isotropic nature of the cosmic background radiation in the Universe and the demonstration of its blackbody spectrum have generally been taken to imply "big bang" characterization. The present communication shows that such radiation could also be present in an Eddington−Lemaitre type Universe, expanding from a finite static state in the infinite past. The model proposed might be termed the "cool model," since for reasonable values of the parameters involved the temperature of the radiation is always quite low. (UK)

5018 VARIABILITY OF CENTAURUS XR-2. Francey, R. J. (Univ. of Tasmania, Hobart); Fenton, A. G.; Harries, J. R.; McCracken, K. G. Nature (London), 216: 773-4(Nov. 25, 1967).

It was reported that the x-ray flux from Centaurus XR-2 varied between 1965 and 1967. This communication details observed changes during April to May 1967, when it was found that during this time the x-ray energy output decreased approximately exponentially as a function of time, with a time constant of 25 days. The data were obtained from x-ray detectors flown on two Skylark rockets launched from Woomera and from an experiment flown from Hawaii by the Livermore Research Laboratory Group. The spectral information from the Skylark detectors covered the energy bands 2 to 5 keV and 5 to 8 keV. Results are shown graphically, including calculated plasma temperatures. Decrease in energy output was accompanied by a softening of the x-ray spectrum.

The data do not make it possible to determine whether the variation was periodic or aperiodic, but it was indicated that the variability was transient. The observed decay time constant of 25 days agrees within a factor of two with the constants of type-II supernovae, suggesting some similarity of phenomena. Any optical counterpart of the x-ray variability may have escaped detection. (UK)

5019 DIAMETERS OF SOME QUASARS AT A WAVELENGTH OF 66.9 cm. Broten, N. W. (National Research Council, Ottawa); Clarke, R. W.; Legg, T. H.; Locke, J. L.; McLeish, C. W.; Richards, R. S.; Yen, J. L.; Chisholm, R. M.; Galt, J. A. Nature (London), 216: 44-5(Oct. 7, 1967).

The measurement of the diameter of radio sources in the range of 10^{-2} sec. of arc, or less, has been made possible by a new technique in radio-interferometry, in which independent stable local oscillators are used to convert the signals at two stations to frequencies recorded on magnetic tapes. In principle the long baseline interferometers can operate at any separation. Measurements at 66.9 cm wavelength with baselines of 183 km ($2.7 \times 10^5\lambda$) and 3,074 km. ($4.6 \times 10^6\lambda$) have been reported from Canada. Fringes of amplitude greater than 4 flux units were detected from eight sources. The fringe visibilities determined from both baselines are shown in tabular form. The effect of interplanetary scintillation on fringe amplitudes is discussed, and it is concluded that this effect is small. Results are analyzed. (UK)

5020 MICROWAVE BACKGROUND IN A STEADY-STATE UNIVERSE. Narlikar, J. V.; Wickramasinghe, N. C. (Cambridge Univ., Eng. Univ. of Maryland, College Park). Nature (London), 216: 43-4(Oct. 7, 1967).

It has been widely claimed that observed background microwave radiation must originate from a radiation dominant early phase of the Universe. Hoyle and others have, however, discussed the possibility of a more local origin for this radiation. They point out that the energy density arising from the conversion of hydrogen to helium in all galaxies is about 10^{-13} erg/cm^3, close to the energy density of the 3 °K black body field. If an appreciable fraction of this energy could be thermalized by dust grains the observed "black body" microwave spectrum might be explained. The requirement is that quantum oscillators covering much of the frequency range 0.01 to 10 cm^{-1} are present in the grains. There is strong evidence for the existence of oscillators close to about 10 cm^{-1}, and such frequencies may be appropriate for the oscillation of weakly bound substitutional impurities in crystals. In the present communication the effect is considered of a few strong emission bands at about 1 to 10 cm^{-1} which may be present in the grains. From a total of about 10^{65} grains in the Galaxy, each containing about 10^5 impurity oscillators, an infrared emission at about 10 cm^{-1} could be obtained, equal to approximately one-third of the entire luminosity of the Galaxy. This flux of galactic radiation at $\nu \sim 10$ cm^{-1} could produce the observed excitation of the J = 1 rotational levels of CN, but would not account for the microwave observations. The consequences of a similar process operating in other galaxies is considered. The simple case in which the thermalization mechanism in the interstellar dust of each galaxy results in the radiation of a sharp line of frequency ν_0 is first considered. Although each galaxy emits a sharp line, the net contribution from all galaxies results in a continuum spectrum. It is of interest to note that the spectrum continues only on the long wavelength side of the line emitted by a typical galaxy. More complicated forms are then considered. In young spiral galaxies it cannot be ruled out that the total stellar emission in the uv exceeds the visible output by a factor of 10 to 100. Dust grains present in such galaxies would absorb this radiation with an efficiency factor about five times greater than for visible light, and re-radiate the energy in the microwave spectral region. The microwave power of galaxies could thus exceed the visible power by a factor of about 100. Reference is made to the close equality between the energy density of the microwave background and that of several galactic fields (cosmic rays, galactic magnetic field, etc.). (UK)

5021 LIMITS ON SMALL-SCALE VARIATIONS IN THE COSMIC BACKGROUND RADIATION. Conklin, E. K.; Bracewell, R. N. (Stanford Univ., Calif.). Nature (London), 216: 777-8(Nov. 25, 1967).

The 3°K microwave background radiation left over from the "big bang" would exhibit features of small angular size if at the time of escape of the radiation there were density inhomogeneities. Observational evidence for, or limits to, such non-uniformity bears directly on questions such as the origin of galaxies and their magnetic fields. The authors have previously reported limits on the root mean square temperature fluctuation, σ, of 5.1 millidegrees K at an angular scale of 1°, and 3.6 millidegrees K at a scale of 6°, measured over a small region of the sky, and limits at a scale of about 15° are deducible from the observations of other workers. A survey of a larger section of sky is now reported, from which upper limits to σ can be set for scales up to 2°. Experimental work is described. (UK)

5022 DOES THE FINE-STRUCTURE CONSTANT VARY WITH COSMIC TIME? Bahcall, John N. (California Inst. of Tech., Pasadena); Schmidt, Maarten. Phys. Rev. Lett., 19: 1294-5(Nov. 27, 1967).

The fine structure constant at redshifts $\Delta\lambda/\lambda \approx 0.2$, corresponding to an epoch around two billion years ago, was determined using the wavelengths of a pair of O III emission lines measured in the spectra of five radio galaxies. A probable error $\alpha(z = 0.2)/\alpha(\text{lab}) = 1.001 \pm 0.002$ was found. (auth)

5023 CHEMICAL FRACTIONATIONS IN METEORITES. I. CONDENSATION OF THE ELEMENTS. Larimer, John W. (Univ. of Chicago). Geochim. Cosmochim. Acta, 31: 1215-38 (Aug. 1967).

The condensation history of a cooling gas of cosmic composition is outlined. Two condensation sequences are derived: one for fast cooling, with the formation of pure elements and compounds, and another for slow cooling, with the formation of solid solutions. These sequences bear a striking resemblance to the depletion patterns observed in ordinary chondrites. Pb, Bi, In, and Tl, which are most strongly depleted, are among the last elements to condense, with condensation temperatures <500°K at a total pressure of 6.6×10^{-3} atm. A somewhat less strongly depleted group (Zn, Cd, Ag, and probably Te and Se) condenses near 680°K, which is also the temperature at which FeS forms according to the reaction $Fe + H_2S = FeS + H_2$. Finally, elements showing only moderate depletion (Sn, Ga, Ge, Au, and Cu) condense between 700 and 1000°K. Manganese and the lighter alkalis (Na, K, and Rb), elements depleted in carbonaceous but not in ordinary chondrites, lie still higher in the sequence, between 1100 and 1300°K. It is proposed that the fractionation patterns observed in chondrites arose in the solar nebula during condensation and accretion. Subsequent heating in a meteorite parent body does not appear to have effected any further fractionations, with the possible exception of the most volatile trace elements, the noble gases and Hg. (auth)

5024 PROCEEDINGS OF THE FIFTH ANNUAL EASTERN THEORETICAL PHYSICS CONFERENCE, BROWN UNIVERSITY, PROVIDENCE, NOVEMBER 25–26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967. 256p. (CONF-661129). DTIE.

The conference consisted of invited papers only, devoted to various areas of current interest in high-energy physics, astrophysics, and solid state physics and the many-body problem. Separate abstracts were prepared for the fifteen papers. (W.D.M.)

For abstracts of individual papers see: 5025–5028, 5444–5446, 5524, 5542, 5562, 5592, 5616, 5649, 5678, and 5679.

5025 RELATIVISTIC COSMOLOGY. Schuecking, E. L. (Univ. of Texas, Austin). pp 3-10 of Proceedings of the Fifth Annual Eastern Theoretical Physics Conference, Brown University, Providence, November 25–26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-661129.

Relativistic cosmology is discussed in terms of homogeneity and isotropy, Friedman models, and parameters of Friedman models. (W.D.M.)

5026 INTERSTELLAR MOLECULES. Salpeter, E. E. (Cornell Univ., Ithaca, N. Y.). pp 11-23 of Proceedings of the Fifth Annual Eastern Theoretical Physics Conference, Brown University, Providence, November 25–26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-661129.

The question of the abundance of molecular hydrogen in interstellar space is considered along with the abundance of other possible molecules. OH omission and maser action in interstellar space is also discussed. (W.D.M.)

5027 STATES OF MATTER IN STARS. Ruderman, Malvin A. (New York Univ., N. Y.). pp 25-41 of Proceedings of the Fifth Annual Eastern Theoretical Physics Conference, Brown University, Providence, November 25–26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-661129.

The evolution of a star is generally toward states of increasing density as energy is lost by radiation. The contraction can be halted permanently only when electron degeneracy pressure or neutron pressure becomes sufficiently great. One has then three possible final states for an evolving star which depend upon their terminal mass: (a) $M \gtrsim 2M_\odot$ (indefinite contraction toward the Schwarzschild singularity); (b) $M \gtrsim 2M_\odot$ (neutron stars); and (c) $M \gtrsim 1.2\ M_\odot$ (white dwarfs). A discussion is given on the states of matter in neutron and white dwarf stars. (W.D.M.)

5028 THERMAL X RAYS AND RADIO SOURCES: EXPLOSION AFTERMATH. Morrison, Philip (Massachusetts Inst. of Tech., Cambridge). pp 43-61 of Proceedings of the Fifth Annual Eastern Theoretical Physics Conference, Brown University, Providence, November 25-26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-661129.

Remarks are presented on what defines the x-ray region and what the experimental situation is. The types of x-ray sources are discussed, along with one or two mechanisms which might serve as a model for the sources. (W.D.M.)

5029 SPECTROSCOPIC AND PHOTOMETRIC STUDY OF THE Ap STARS. Wolff, Sidney Carne. Berkeley, Calif., Univ. of California, 1966. 98p.

Thesis.

Effective temperatures are derived for a number of Ap and normal A-type stars by comparing observed energy distributions in the interval λλ 4000 to 8000 with theoretical models. Surface gravities are derived from measurements of Hγ profiles. It is shown that the temperatures and surface gravities are like those of normal main sequence stars of spectral types B3-A8. Measurements of line blocking coefficients are used to correct the observed B-V colors for blanketing. The corrections are found to be small for all but the coolest Ap stars. Corrections to U-B have been derived for five stars, and these corrections are also small. The corrected colors are used to plot the Ap stars in a color-magnitude array and in the two-color diagram. The derived temperatures have been used to estimate the abundances, relative to Fe, of a number of elements which characteristically show abnormal line strengths in Ap stars. The relation between temperature and kind of peculiarity is discussed. Finally it is shown that there is a correlation between the strength of the Eu II lines, the values of $\bar{\eta}$, the average line blocking coefficient, the Stromgren index m_1, and apparent rotational velocity. The evidence is consistent only with the hypothesis that the Ap stars are slow rotators, not rapid rotators seen pole-on. (Disser. Abstr.)

5030 DETAILED PHOTOMETRY OF SIX Sb GALAXIES. Simkin, Susan Marguerite Smith. Madison, Wis., Univ. of Wisconsin. 153p.

Thesis.

Photoelectric observations of surface brightness in the UBV system were obtained for six nearby Sb galaxies, NGC 2683, 3031, 4216, 4736, 4826, and 5746. Photoelectric observations for two of these systems, NGC 4216 and 5746, were also obtained in the RI system. All photoelectric observations were through very small apertures (6.7 and 12.8 seconds of arc). Photographic plates in the UBVRI system were taken for all of the six galaxies listed and isophotes constructed for all but the U and B plates of NGC 4736. These isophotes were calibrated by means of the photoelectric observations. The isophotes for these objects show a tendency to be flatter in the intermediate regions than in either the inner or outer regions. Some possible causes of this effect are discussed briefly. The colors for the interarm disk population of these objects show a tendency to approach those expected for a star of the same type as the spectral class of the galaxy as a whole. The colors for the inner arms of NGC 4736 and those for the outer arms of NGC 3031 (M81) are quite dissimilar. The differences are tentatively interpreted in terms of reddening within the arms of NGC 3031. The observational material has been used to calculate asymmetry functions for the colors and color indices of these objects. Inspection of these functions reveals that there is a tendency for all of the objects to become brighter in the outer regions of their "more obscured" side in ultraviolet light. Examination of the integrated color indices for the regions where this effect occurs seems to indicate that it becomes more pronounced for longer wavelength regions of the spectrum as the tilt of the object increases. (Disser. Abstr.)

5031 SELF-CONSISTENT MODELS OF DISC GALAXIES. Ng, Edward Wai-Kwok. New York, Columbia Univ., 1967. 107p.

Thesis.

Theoretical self-consistent models for disc-like galaxies are dealt with. The idealized models are supposed to consist only of stars. The following assumptions are made: (i) no stars are created or destroyed in the system; (ii) the effects of stellar encounters are negligible; (iii) the system is self-gravitating, i.e., each star moves independently in the collective gravitational field of all the others; (iv) the system is in a steady state; (v) the system can be approximated by an infinitesimally thin disc with axisymmetric density distribution. The models are then described by two coupled equations, namely, the collision-free Boltzmann equation, which governs the stellar distribution function, and Poisson's equation, which relates the gravitational potential to the density distribution. A special form of the stellar distribution function has been taken as the solution of the Boltzmann equation, viz.,

$$f(E,J) = \begin{cases} Ae^{-\alpha E+\beta J} & \text{for } E \le E_0 < 0 \\ 0 & \text{for } E > E_0 \end{cases}$$

where E and J are the energy and angular momentum integrals of the equations of motions; A, α and β are free parameters; and E_0 is a cutoff energy defined by the size of the disc. This function is substituted in the right-hand side of Poisson's equation, which then becomes a nonlinear equation for the potential. An iterative procedure for the solution of this equation has been developed and numerical results have been obtained with the Columbia University IBM 7094 computer for different values of the relevant parameters. Some models of particular relevance to our galaxy are discussed in detail. (Disser. Abstr.)

5032 QUASI-STELLAR SYNCHROTRON SOURCES AND INTERGALACTIC MATTER. McCray, Richard Alan. Los Angeles, Univ. of California, 1967. 146p.

Thesis.

Synchrotron radiation in a medium is examined with application to two star-like objects which may be synchrotron sources. The first is the galactic object Eta Carinae. In Part One a physical model for this object is described under the assumption that the optical continuum is synchrotron radiation. Various mechanisms for the suppression of low-frequency synchrotron radiation are discussed, and it is concluded that the absence of measurable radio emission from Eta Carinae is explained by the Razin effect. Strong radio emission is predicted for wavelengths shorter than one cm. The x-ray and gamma-ray fluxes from the object due to inverse Compton scatterings is estimated. It is shown that the flux of ~100 MeV γ rays should be measurable, while the x-ray flux is more uncertain. The interrelation of fluxes in the cm-mm radio band, infrared, x rays, and γ rays is discussed. In Part Two the theory of optically thick synchrotron sources is investigated in further detail. It is shown that the Razin effect makes negative synchrotron reabsorption, or "maser action" possible. A model for the presumably extra galactic quasi-stellar radio source, 3C 273B, is described in which maser action contributes to the low-frequency radio emission. In Part Three the possible thermal histories of a hypothetical intergalactic hydrogen gas in an evolutionary cosmology are investigated. The physical processes controlling the ionization level and temperature of the gas and the intensity of the radiation field are discussed. Starting from certain specified initial conditions at an early stage of the Universe, the time development of such a gas is followed by numerically integrating the relevant differential equations on a high-speed digital computer. Comparison of solutions with observations of radiation from distant sources places constraints on physical conditions at an earlier epoch. (Disser. Abstr.)

5033 NUCLEAR ASTROPHYSICS. Fowler, William A. Jayne Lectures for 1965. Philadelphia, American Philosophical Society, 1967. 121p. $3.00.

A nonmathematical account of the principles of nuclear physics involved in the synthesis of the elements is given. The processes by which hydrogen is converted into helium in main-sequence stars like the Sun are described and the steps are followed by which in astronomical bodies of other classes—giant stars, supernovae, and quasars—the more complex elements are, in their several ways, built up and then distributed into the interstellar medium from which new stars are formed. These processes are used to date the earliest formation of elements in the Galaxy. (W.D.M.)

Atomic and Molecular Physics

Refer also to abstract 5492.

5034 (BMwF-FBK-67-74) BERECHNUNGSMOEGLICHKEITEN FUER DIE BILDUNG VON CLUSTER-IONEN. (Theoretical Approach to the Problem of Cluster Ion Formation). Hohla, Chr.; Mohnen, V. (Munich Univ. (West Germany)). Aug. 1967. 49p. (In German). Dep.

Usually the mass of an ion is not the same as it was immediately after the ionization process. Cluster ions are formed by the attachment of neutral atoms or molecules. The number of attached atoms or molecules was calculated on the basis of an equilibrium condition. In order to demonstrate this method the relatively simple system of lithium ions in krypton was used. For the calculation of the partition function one has to know the potential distribution as well as the ionic radius. By the proposed method one can estimate or calculate the number of attached atoms or molecules as functions of pressure and temperature and for each system of constituents. (auth)

5035 (IPP-2/13) EXPERIMENTE AN EINER IONEN-STRAHLAPPARATUR. (Experiment in an Ion Beam Apparatus). Herrmann, W. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). May 1963. 60p. (In German). Dep.

The ion beam apparatus consists of three parts: the ion source, the lens, and various collectors as measurement devices. The duoplasmatron was used as the ion source. The productivity of the source for ions and electrons was investigated as a function of the various source parameters. Various types of electrostatic single lenses were used for focusing. The most suitable was the 4-electrode single lens which in addition to good focusing properties also causes a space charge compensation of the beam. The properties of the beam were investigated, especially its density, composition, and oscillations. The oscillations originate with the ion source. Its frequency oscillates between 0.9 and 1.5 MHz. In the oscillations it is a matter of density oscillations which are not accompanied by energy oscillations. (tr-auth)

5036 (JINR-P9-3474-2) USTOICHIVOST' KOL'TSEVOGO TOKA V TSILINDRICHESKOM REZONATORE. (Stability of a Ring Current in a Cylindrical Resonator). Ivanov, I. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 14p. (In Russian). Dep.

If charged beams are inserted in the resonator, then instabilities can arise in it, connected with the interaction of the beam with the natural field of the resonator. An instability of such a type was investigated for ring configurations in the cylindrical resonator. The increments of the growth of the instability in infinitely fine current ring was found. The results were easily generalized to the formation of the type of E layers. All examinations were made in the framework of hydrodynamics with zero thermal moments. (tr-auth)

5037 (JINR-P9-3475-2) USTOICHIVOST' OKRUZHENNOGO METALLICHESKIM EKRANOM TSILINDRICHESKOGO SLOYA ELEKTRONOV V ODNORODNOM MAGNITNOM POLE. (Stability of a Cylindrical Layer of Electrons Surrounded by a Metal Screen in a Homogeneous Magnetic Field). Ivanov, I. N.; Makhan'kov, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 17p. (In Russian). Dep.

The stability of a thin cylindrical electron layer in a magnetic field, in a smooth wave guide (the conductivity of the walls of which are assumed infinite) was investigated. It is shown that not only longitudinal instabilities of the "negative" mass type are indicated, but transverse channels of instability as well. In contrast to flat geometries, where the increments of channeled instabilities in the presence of screens were increased, in cylindrical layers of screens instabilities of such a type are liquidated. (tr-auth)

5038 (JINR-P9-3476-2) VLIYANIE EKRANIROVKI NA EFFEKT OTRITSATEL'NOI MASSY. (Screening Influence on the Negative Mass Effect). Ivanov, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 14p. (In Russian). Dep.

The effect of the conducting surface on the development of instability of the negative mass type was investigated for the case of infinite completely charged cylinders with azimuthal current, surrounded by metallic jacket. It was shown that the screening decreases the increments of growth of the instability. (tr-auth)

5039 (NP-17144) ATOMIC SCATTERING STUDIES USING SOLID TARGETS (ENERGY RANGE 10-100 keV). Snoek, Cornelis (Amsterdam Univ. (Netherlands)). 1966. 93p. Dep. Thesis.

Collisions of Ar^+ ions against Cu atoms at kinetic energies of 40, 60, and 90 keV were used to study the uses and limitations of solid targets in atomic scattering studies. Absolute measurements of the number of particles scattered in various directions from the (110) surface of a Cu single crystal were made. It was found that these measurements could not be used for determination of the interatomic potential but could be used with an appropriate potential model for determination of the neutral contribution to the scattered particles. Measurements of inelastic energy losses during collisions of Ar^+ ions with Cu atoms at the surface of a solid and with atoms in a Cu vapor beam indicated that the dynamics of atomic collisions is not influenced by the physical state of the target. Differences in energy losses at scattering angles where the outgoing particles leave the target at grazing angles were attributed to additional scattering against neighboring atoms at the surface. The high-energy part (>50 eV) of the energy spectrum of the electrons emitted by metallic targets during ionic bombardment was investigated. It appeared that this spectrum consisted of a background decreasing rapidly at high energies. Superimposed upon this background, peaks characteristic of the collision partners can occur. Possible explanations for these results are considered. (A.G.W.)

5040 (NP-17173) POLARISATION DER KOHAERENTEN BREMSSTRAHLUNG VON EXTREMRELATIVISTISCHEN POLARISIERTEN ELEKTRONEN. (Polarization of Coherent Bremsstrahlung by Extremely Relativistically Polarized Electrons). Neumcke, Berthold (Munich Univ. (West Germany)). 1967. 58p. (In German). Dep.

If unpolarized extreme relativistic electrons strike a single crystal, the spectrum of the arising bremsstrahlung has high-intensity peaks and the entire bremsstrahlung in these peaks is transversally polarized with respect to a crystal plane. The present calculations show that the bremsstrahlung of longitudinally polarized electrons from an amorphous target as well as from a crystal has the same circular polarization at all photon energies. Therefore intensive high-energy circularly polarized γ rays are obtainable by coherent bremsstrahlung. No additional circular photon polarization arises from deceleration of transversally polarized electrons in a crystal. A possibility of a measurement of the longitudinal polarization of extreme relativistic electrons by using the coherent bremsstrahlung is discussed. As the usual methods leave much to be desired at these energies, one may transfer the longitudinal electron polarization by coherent bremsstrahlung to a circular photon polarization and convert it by another crystal into a transversal photon polarization. This polarization is then measurable with good accuracy by asymmetries in pair production. (auth)

5041 (NYO-3708-5) A STUDY OF ALPHA PARTICLE REACTIONS IN ATMOSPHERIC GASES. Fifth and Sixth Quarter Progress Report, April 15-November 15, 1967. CAL Report No. VC-2279-P-5. Fluegge, Robert A. (Cornell Aeronautical Lab., Inc., Buffalo, N. Y.). Nov. 30, 1967. Contract AT(30-1)-3708. 6p.

Experiments were performed to obtain ionization cross sections as a function of energy for alpha particles in helium. The results are shown. (M.O.W.)

5042 (ORO-2591-33) EMISSION AND EXCITATION CROSS SECTIONS. Progress Report No. 3, December 1, 1966-November 30, 1967. Thomas, E. W.; Edwards, J. L.; Bent, G. D. (Georgia Inst. of Tech., Atlanta. School of Physics). Dec. 1, 1967. Contract AT(40-1)-2591. 38p. Dep. CFSTI.

The objectives and general methods of a program for measurement of cross sections for production of particles in excited states as the result of the impact of 0.15- to 1.0-MeV protons on various gaseous targets under single-collision conditions are discussed. Reports are listed in which completed work is described. Some additional observations not to be published because they are considered of poor quality are discussed briefly. These observations concern formation of excited states in He, N_2, O_2, H_2, and Ar. Preliminary results on Balmer alpha emission following proton impact on nitrogen are also presented briefly. (A.G.W.)

5043 (ORO-2591-34) IONIZATION AND CHARGE TRANSFER CROSS SECTIONS. Progress Report No. 20, December 1, 1966-November 30, 1967. Martin, D. W.; Taylor, G. O. (Georgia Inst. of Tech., Atlanta. School of Physics). Dec. 1, 1967. Contract AT(40-1)-2591. 25p. Dep. CFSTI.

The general objectives of a program of absolute cross-section measurements for charge rearrangement collisions of fast (0.15 to 1.00 MeV) hydrogen and helium ions and atoms in gaseous targets and the overall plan of the experiment are discussed. Essentially all of the effort during the current report period went into the further construction of the differential coincidence analyzer apparatus. Work on the following parts of the apparatus is described: the retarding potential electrode assembly, the detector for the recoil-ion analyzer, the fast-beam analyzer, alignment, and the auxiliary ion source. (A.G.W.)

5044 (ORO-3349-3) RADIATION INDUCED LUMINESCENT PROCESSES IN GASES. Progress Report. Glick, R. E.; Keirs, Russell J. (Florida State Univ., Tallahassee). Dec. 8, 1967. Contract AT(40-1)-3349. 37p. Dep. CFSTI.

Experiments are reported describing luminescent processes resulting from 5-MeV-proton and 3-MeV-electron bombardment of gases at pressures from a few millimeters to several atmospheres. Luminescence does not appear to be traceable to direct transfer from the high-energy source to the system, but is induced by secondary electron processes. This is concluded from the fact that to the limit of quantitative comparison, identical luminescent features are found when either energetic particle is employed as the exciting source. Collisional titration of excited nitrogen species formed on irradiation of pure nitrogen provides additional confirmation of this conclusion. These conclusions are based, in part, on certain experimental quantities previously determined in this program and required in all such studies. These include cross sections for excitation, emission, and luminescence quenching.

These and further energy transfer cross sections are under investigation as is another method of testing the conclusions. A device for scanning the luminescence profile in the neighborhood of a high-energy beam was recently constructed. (auth)

5045 (UCRL-17909) RADIO FREQUENCY STARK SPECTRA OF RbF, RbCl, CsF, CsCl, AND NaI. Lovas, Francis John (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1967. Contract W-7405-eng-48. 87p. Dep. CFSTI.

Thesis.

The molecular beam electric resonance method was used to measure the radio-frequency Stark spectra of ^{85}RbF, ^{87}RbF, ^{85}Rb^{35}Cl, CsF, Cs^{35}Cl, and NaI. Weak field measurements were made on RbF to obtain accurate hyperfine-structure constants. Intermediate- to strong-field measurements were made on all the above molecules to obtain dipole-moment values for the three lowest vibrational states of the J = 1 or 2 rotational state. Work on a polarizable ion model of the alkali metal halides, which computes dipole moments, the molecular dissociation energy, and the second coefficient of the Dunham expansion of the potential energy, is also presented. Good agreement with experimental values is obtained. (auth)

5046 (NP-tr-1599) OPTIMISATION OF THE GIESSEN ION THRUSTOR. Freisinger, J.; Loeb, H. Translated for Culham Lab., Abingdon, Eng., from Raumfahrtforschung, 10: 174-9(1966). 18p. (CTO-423). Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

A mercury ion thrustor with a high-frequency ion source, which started operating during April 1964, was optimized between September 1964 and January 1966. By using small permanent magnets the discharge pressure could be decreased and a resonance-like increase in the power pickup of the discharge plasma was obtained. The ion extraction system was improved in the course of numerous series of tests. As a result of the optimization the original thrust was increased 5 times, the energy efficiency by 12%, the utilization efficiency by 5%, and the total efficiency by 15%. On completion of the tests, with an ion source volume of 0.5 lit the thrust was 1 p and the total efficiency 82.5%. (auth)

5047 NEUTRONIC ATOM RADIATION. Bagrov, V. G.; Stepanov, V. E. (Siberian Physical-Technical Inst., Tomsk, USSR. Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 6, 142-4(1967). (In Russian).

The neutron, which possesses an anomalous momentum in a magnetic field of the type $\vec{H}$ (0, 0, $\gamma/\mu r$), can complete a finite motion and possess a discrete spectrum of energies, where the neutron motion is analogous to the motion of an electron in a hydrogen atom. The wave functions of a neutron moving in the magnetic field are written, and expressions for the intensity of two linearly and two circularly polarized components of radiation are obtained. It is found that the neutron radiation during transitions in the discrete spectrum has a strongly linear polarization and has hardly any circular polarization. The intensity and probability of emission are small at small values of γ. It is noted with interest that the polarization properties of neutron radiation are close to the polarization properties of the synchrotron radiation of a relativistic electron. The possibility of radiation from a neutral particle moving in a magnetic field of special configuration is of theoretical interest. (TTT)

5048 UP-TO-DATE METHODS FOR STUDYING STARK EFFECTS IN ATOMS. Bonch-Bruevich, A. M.; Khodovoi, V. A. Usp. Fiz. Nauk, 93: 71-110(Sept. 1967). (In Russian).

Observational methods and results of investigations of shift and level splitting in constant and alternating electric fields are discussed. A theoretical interpretation is given for the Stark effect in optical frequency dc and ac electric fields. Correlations of computed and measured constants of the quadratic Stark effect in static fields for atoms of alkali metals showed that the theoretical calculations of the Stark constants for frequency shifts in optical transitions, considering spin-orbital interactions, are in agreement with the experimental data. However, calculations of frequency shifts in transitions between hyperfine levels of the ground-state atoms of alkali metals were much higher than those obtained by experiments. 69 references are included. (R.V.J.)

5049 THEORY OF INTENSITY BEATS OF SECONDARY RADIATION OF AN ATOM WITH A NONDIAGONAL EXTINCTION MATRIX. Morozov, V. A. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 1-4(July 1967).

Translated from Opt. Spektrosk., 23: 3-9(July 1967).

Quantum electrodynamics methods are used to obtain an expression for the amplitude of the intensity beats of secondary radiation from an atom with a nondiagonal extinction matrix (two coupled degenerate excitation levels with different radiation widths) following irradiation with light of modulated intensity. The influence of the nondiagonal extinction-matrix elements of the dependence of the beat amplitude on the modulation frequency and on the distance between the stationary coupled excitation levels is investigated. An experimental investigation of this dependence can serve as a check on the theory of radiation conversion by an atom with a nondiagonal extinction matrix. Two cases are considered: irradiation with light having a broad spectrum and irradiation with monochromatic light. (auth)

5050 MULTIPHOTON IONIZATION OF THE HYDROGEN ATOM. Shaparev, N. Ya. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 96(July 1967).

Translated from Opt. Spektrosk., 23: 178-80(July 1967).

Multiphoton ionization is one of the possible processes in the breakdown of gases in a strong electromagnetic field. An analysis is performed on this process with due allowance for the transition through the excited state. Perturbation theory is used, and the probability of ionization from the excited state is calculated. The time is determined to be $\pi/2 \times 10^{-15}$ sec. (D.L.C.)

5051 CALCULATION OF THE EFFECTIVE POTENTIALS OF MANY-ELECTRON ATOMS FROM SPECTROSCOPIC DATA. Zhirnov, N. I. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 5-7(July 1967).

Translated from Opt. Spektrosk., 23: 10-14(July 1967).

A method has been worked out for calculating the effective potentials of many-electron atoms from experimental values of x-ray terms, similar to the Rydberg-Klein-Rice method used for constructing the potential curves of diatomic molecules. The method was used to calculate the potential of the tungsten atom. (auth)

5052 SEMICLASSICAL THEORY OF INELASTIC SCATTERING. Cross, R. J. Jr. (Yale Univ., New Haven). J. Chem. Phys., 47: 3724-35(Nov. 15, 1967).

The Schiff approximation is applied to the problem of collisions of two asymmetric molecules. The treatment includes effects of energy interchange between translational and internal degrees of freedom, and it includes transitions to states not directly coupled by the intermolecular potential. The differential and partial scattering cross sections are obtained in terms of a phase-shift matrix which is a generalization of the WKB phase shift. This matrix may be obtained simply as an integral of the matrix of the intermolecular potential over the classical trajectory. Semiclassical approximations similar to those used in the case of elastic scattering are made, and the angular distribution reduces to the previously obtained classical expression. The approximations used in the derivation are that l and k (the orbital angular momentum quantum number and the wavenumber) must be large and $\Delta k/k$ must be small. The calculations are reasonably simple for scattering below about 30° where the scattering may be considered as a perturbation on a straight-line trajectory. (auth)

5053 BORN INELASTIC DIFFERENTIAL CROSS SECTIONS IN H_2. Miller, Kenneth J.; Krauss, Morris (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 47: 3754-62 (Nov. 15, 1967).

First Born differential cross sections are calculated for inelastic electron scattering of 300-eV electrons off H_2 for excitations from the ground electronic-vibrational state into the vibrational levels of the B, B', C, D, and D' Rydberg states. The initial and final state electronic wavefunctions were approximated by Hartree-Fock functions. In order to facilitate the calculation, the molecular orbitals were expanded in a linear combination of Gaussian-type atomic orbitals. The variation of the electronic scattering amplitude was examined as a function of molecular orientation, internuclear separation, and scattering angle (or electron momentum transfer). It is shown that the use of the Franck-Condon factors to determine relative intensities for scattering into different vibrational levels yields errors of less than 20%, and hence these factors are a good approximation to the relative intensities. The theoretical differential cross section for zero-angle scattering is in good agreement with the most recent experimental data, and transition moments extracted from electron scattering experiments within the context of the Franck-Condon principle are in agreement with the theoretical values. (auth)

5054 FLUORESCENCE AND ENERGY TRANSFER BETWEEN Nd^{3+} AND Yb^{3+} IN LaF_3. Rast, H. E.; Caspers, H. H.; Miller, S. A. (Naval Ordnance Lab., Corona, Calif.). J. Chem. Phys., 47: 3874-8(Nov. 15, 1967).

Energy transfer has been observed in single crystals of LaF_3 codoped with Nd^{3+} and Yb^{3+} resulting from the near resonance transitions between states of Nd^{3+} and the $^2F_{\frac{1}{2}} \rightarrow {}^2F_{\frac{5}{2}}$ states of Yb^{3+}. From an analysis of the fluorescence and absorption spectra of Yb^{3+}, all the crystalline field Stark components of the $^2F_{\frac{1}{2}}$ and $^2F_{\frac{5}{2}}$ state were determined. The four crystal sublevels of the $^2F_{\frac{1}{2}}$

ground states are found at 0, 185, 401, and 870 cm^{-1}. The three levels of the excited $^2F_{\frac{5}{2}}$ states are determined at 10,260, 10,430, and 10,660 cm^{-1}, respectively. Based on these values of the Stark levels, the spin–orbit coupling radial integral for Yb^{3+} in LaF_3 is calculated to be 2882 cm^{-1}. (auth)

5055 N REPRESENTABILITY OF FERMION DENSITY MATRICES. Freed, Karl F. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 47: 3907-11(Nov. 15, 1967).

The proof of Smith, which gives the solution to the N-representability problem of the first-order density matrix for the case of N even and a nondegenerate energy eigenstate, is also shown to be valid for certain linear combinations of degenerate states. A connection is shown between these proper linear combinations and the eigenfunctions of a perturbed Hamiltonian for which all of the degeneracies have been lifted. For the case of S = 0, all the eigenfunctions of the pth-order density matrix (natural p functions) can be taken to be eigenfunctions of total spin $(\Sigma_{j=1}^{p} S_j)^2$, and if orbital angular momentum is a constant of the motion, these natural p functions are eigenfunctions of the total orbital angular momentum for L = 0. Simple wavefunctions are presented for which the natural 2 functions are not all eigenfunctions of the total pair spin. It is then shown that for $M_S = 0$ (any integral spin) or for L = 1, $M_L = 0$, the natural 2 functions are eigenfunctions of $(S_1 + S_2)^2$ and $(L_1 + L_2)^2$, respectively. (auth)

5056 LOWER BOUNDS TO EIGENVALUES OF THE SCHROEDINGER EQUATION. I. FORMALISM FOR EXCITED STATES. Wilson, Timothy M. (Univ. of Florida, Gainesville). J. Chem. Phys., 47: 3912-19(Nov. 15, 1967).

A procedure is presented for the calculation of lower bounds to the excited states of a Hamiltonian of the type $\mathcal{H} = \mathcal{H}_0 + V$, where $\mathcal{H}$ is bounded below and self-adjoint, V is positive definite, and $\mathcal{H}_0$ has a known set of eigenfunctions. This procedure is derived using the partitioning technique. A detailed study is made into the effect that replacing the reaction operator $t(\epsilon)$ by its inner projection onto some linear manifold f has on the curves of the multivalued bracketing function. From this analysis it is shown for the first time that when the linear manifold, onto which the projection of $t(\epsilon)$ is made, is of the type $f = t(\epsilon)^{-\frac{1}{2}}(\epsilon - \mathcal{H}_0)j$, the bracketing curves are no longer monotonically descending when plotted as a function of ϵ. This result is very important in the calculation of lower bounds to excited states. (auth)

5057 LOWER BOUNDS TO EIGENVALUES OF THE SCHROEDINGER EQUATION. II. APPLICATION TO HELIUM AND Li^+. Wilson, Timothy M.; Reid, Charles E. (Univ. of Florida, Gainesville). J. Chem. Phys., 47: 3920-6(Nov. 15, 1967).

The procedure developed in the preceding paper is used to calculate lower bounds to some of the low-lying ^3S levels of helium and Li^+. These calculations are the first applications of the partitioning technique to the excited states of atoms. They are made using the manifolds $f = t(E)^{-\frac{1}{2}}(E - \mathcal{H}_0)j$ and $f = t(E)^{-\frac{1}{2}}h$ to construct the inner projection $t(E)'$. In the latter case, a truncated reduced resolvent $T_0(p)$ was used to approximate T_0. The effect that these projections have on the curves obtained by plotting the multivalued function ϵ'_j as a function of ϵ for these two cases, is also presented. The results seem to indicate that the use of the former manifold to construct $t(\epsilon)'$ leads to quite close bounds for the ground states but the projection constructed using the latter manifold is better for treating the excited states. The relationships between this method and other lower bound procedures are discussed. (auth)

5058 SOME HARTREE–FOCK RESULTS FOR TWO- AND FOUR-ELECTRON ATOMIC SYSTEMS. Froese, Charlotte (Univ. of British Columbia, Vancouver). J. Chem. Phys., 47: 4010-15(Nov. 15, 1967).

Some numerical Hartree–Fock results are reported for excited states of two- and four-electron atomic systems. Transition integrals are given and some oscillator strengths are compared with values obtained by other methods. (auth)

5059 COLLISION CROSS SECTIONS OF HYDROGEN AND OTHER IONS AS DETERMINED BY ION CYCLOTRON RESONANCE. Wobschall, Darold; Fluegge, Robert A.; Graham, John R. Jr. (Cornell Aeronautical Lab., Inc., Buffalo). J. Chem. Phys., 47: 4091-4(Nov. 15, 1967).

Through determinations of the widths of ion cyclotron resonance lines as a function of pressure and electric field strengths, the ion–molecule collision cross sections of H^+, H_2^+, H_3^+, He^+, Ar^+, N_2^+, N^+, O_2^+, O_2^-, and O^- were obtained. Agreement with dc mobility data was found. In particular, the minimum in collision frequency for H_3^+ in H_2 at $E/P_0 = 60$ V/cm·torr was confirmed. The cross sections for H_3^+ in H_2 are 275 and 68 $Å^2$ at low and high E/P, respectively. (auth)

5060 THEORY OF ELECTRON COLLISIONS WITH HOMONUCLEAR DIATOMIC MOLECULES. Rozsnyai, Balazs F. (Univ. of California, Livermore). Contract W-7405-eng-48. J. Chem. Phys., 47: 4102-12(Nov. 15, 1967). (UCRL-70230).

Electron scattering phenomena are investigated in the first Born approximation for homonuclear diatomic molecules. The two-center integrals that must be evaluated to find the scattering cross sections are calculated in an approximation which is accurate for small momentum transfer. Application is made to the elastic scattering in H_2 and to some excitational scattering in H_2^+, H_2, and N_2. (auth)

5061 LOW-ENERGY, LARGE-ANGLE ELECTRON-IMPACT SPECTRA: HELIUM, NITROGEN, ETHYLENE, AND BENZENE. Doering, John P.; Williams III, Albert J. (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 47: 4180-5(Nov. 15, 1967).

Electron-impact spectra taken at a fixed scattering angle of 90° and a variety of energies from 10 to 40 eV are reported for helium, nitrogen, ethylene, and benzene. Forbidden singlet-triplet transitions were observed in all the systems studied at all energies. In all cases, the scattering cross sections for various transitions undergo large relative changes near threshold. We find that singlet-triplet transitions become a very important part of the total inelastic scattering cross section below 20 eV. In helium, the spectrum changes radically near threshold. In nitrogen, singlet-triplet transitions dominate the spectrum at energies less than 20 eV. Previous results on the presence of a singlet-triplet transition in ethylene at 4.4 eV have been confirmed. The 6.5-eV ethylene "mystery band" transition was not observed at energies as low as 10.9 eV. In benzene, the lowest triplet state is observed near 3.9 eV as well as the three lowest singlet states. The general utility of the very large angle scattering method is discussed. (auth)

5062 EFFECT OF DOUBLE SCATTERING ON CROSS SECTION MEASUREMENTS AT LARGE MOMENTUM TRANSFER. Chamberlain, G. E.; Simpson, J. Arol; Mielczarek, S. R.; Kuyatt, C. E. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 47: 4266-7(Nov. 15, 1967).

It is pointed out that serious errors due to plural scattering can occur for differential cross-section measurements in a static gas at pressures that might mistakenly be thought adequate to observe only single scattering. Some results for electron scattering in helium are given. (M.O.W.)

5063 STUDIES OF ION-NEUTRAL REACTIONS BY A PHOTOIONIZATION MASS-SPECTROMETER TECHNIQUE. IV. REACTIONS OF He^+ WITH N_2 AND O_2. Warneck, Peter (GCA Corp., Bedford, Mass.). J. Chem. Phys., 47: 4279-81 (Nov. 15, 1967).

The two helium-ion reactions were examined with a photoionization mass spectrometer technique employing experimental conditions and procedures identical to those used previously for argon-ion reactions, except that the ionizing wavelength was 492 Å, slightly below the He^+ threshold. Over-all rate coefficients derived from helium-ion loss upon admixture of nitrogen or oxygen are in good accord with those obtained by other investigators. (M.O.W.)

5064 INFLUENCE OF THE AUTOIONIZATION EFFECT ON THE IONIZATION EQUILIBRIUM. Bely, O. (Observatoire de Nice). Ann. Astrophys., 30: 953-7(Sept.–Oct. 1967).

The additional ionization rates corresponding to the autoionization effect are computed, using estimated Coulomb–Born cross sections, for Fe X to Fe XVI. It is found that this effect multiplies by 6 the ionization rate for Fe XVI and by three for Fe XV. The total ionization and dielectric rates are given for Fe X to Fe XVIII and the ionization equilibrium is computed. The results are briefly discussed. (auth)

5065 MECHANISM OF XENON-LEVEL POPULATION INVERSION IN THE POSITIVE COLUMN OF A HELIUM–XENON MIXTURE. Moskalenko, V. F.; Ostapchenko, E. P.; Pugnin, V. I. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 94-5(July 1967).

Translated from Opt. Spektrosk., 23: 177-8(July 1967).

Measurements of electric and optical parameters are reported for the positive column of a He–Xe mixture, and the mechanism of level population inversion in the $5p^55d - 5p^56p$ transitions is discussed. The measured quantities included electron temperature and density, and populations of the Xe levels 6s, 5d, and 6p. Numbers of quanta emitted and excitations of the 5d and 6p levels are also calculated. It is concluded that the dominating excitation process is direct electron impact from the ground state of the neutral atom, and that the population inversion of Xe levels in the 5d–6p transitions is the result of the difference in the lifetimes of these levels under these direct excitation conditions. (D.L.C.)

5066 PRODUCTION OF THE $^3He^{2+}$ ION BY AN RF ION SOURCE. Orihara, Hikonojo; Hiratate, Yukio; Morita, Susumu (Tohoku Univ., Sendai). Jap. J. Appl. Phys., 6: 1434-8(Dec. 1967).

Production of the $^3He^{2+}$ ion by a rf ion source was observed on a test bench. After accelerating ions to about 20 keV, the beam was analyzed magnetically. The flow rate of the ^3He gas was kept less than 1.0 cc/hr. The effects of magnetic field and location of the rf coupling electrodes on the beam intensity of $^3He^+$ and $^3He^{2+}$ ions were measured. About 0.3 μA of $^3He^{2+}$ ions were obtained. The maximum value of 0.8% was obtained for the ratio of the current intensities of $^3He^{2+}$ and $^3He^+$ ions and the operating condition for obtaining the maximum ratio was determined. Some discussions on the results obtained were made from the point of view of the plasma in magnetic field. (auth)

5067 MEASUREMENT OF THE ABSORPTION OSCILLATOR STRENGTHS OF O I LINES IN VACUUM-UV-SPECTRAL RANGE. Boldt, G.; Labuhn, F. (Max-Planck-Institut fuer Extraterrestrische Physik, Garching, Ger.). Z. Naturforsch., 22a: 1613-15(Oct. 1967). (In German).

The absorption oscillator strengths of the OI-lines at 1152, 1218, 1302, 1305, and 1306 Å are measured in emission. The light source for this purpose is a wall-stabilized cascade arc burning in an argon plasma into which a small quantity of oxygen is introduced. Normal intensities are produced by the same source. The evaluation of particle densities is carried out without assuming constancy of mixture ratio and knowledge of any transition probability. (auth)

5068 APPLICATION OF A SIMPLE DISCHARGE MODEL TO THE INTERPRETATION OF RELATIVE ABUNDANCES OF DIFFERENT TYPES OF IONS EXTRACTED FROM AN ARGON DUOPLASMATRON. Lejeune, Claude; Prangere, Francis (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. A and B, 265: 389-92(Aug. 16, 1967). (In French).

The results of point measurements made with Langmuir probes in several regions of the discharge and the results of the energy analysis of the particles emitted by the extraction orifice have made it possible to develop a simplified discharge model and to interpret several properties of the source. The mass and charge analysis of the extracted ion beams verified the validity of the model by defining the relative importance of different ionization mechanisms. (tr-auth)

5069 MULTIPLE IONIZATION PROCESSES IN HELIUM. Byron, F. W. Jr. (Univ. of Massachusetts, Amherst); Joachain, Charles J. Phys. Rev., 164: 1-9(Dec. 5, 1967).

Double-ionization processes in helium by photon and electron impact are analyzed, and it is shown that the inclusion of atomic correlation is very important. Detailed calculations are performed for the case of photo-ionization over the whole range of photon energies, and the asymptotic behavior of the cross section in the limit of large photon energies is discussed. Excellent agreement is found with recent experimental data. Conclusions are drawn concerning the related electron-impact problem at high incident electron energies. The leading term of the cross section is evaluated, and comparison is made with the presently available experiments. (auth)

5070 QUADRUPOLE SHIELDING AND ANTISHIELDING FACTORS FOR ATOMIC STATES. Sternheimer, R. M. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Rev., 164: 10-20(Dec. 5, 1967). (BNL-11521).

The atomic shielding (or antishielding) factor R for the quadrupole hyperfine structure has been evaluated for several excited atomic states. The values of R were determined by means of the perturbed wave functions $\nu_1'(nl \rightarrow 1')$ as obtained by solving the inhomogeneous Schrödinger equation for each type of excitation of the core electrons by the nuclear quadrupole moment Q. For the case of copper, the calculations provide a quantitative explanation of the fact that the values of $Q(^{63}Cu)$ obtained from two different excited configurations ($3d^94s^2$ and $3d^{10}4p$) differ considerably from each other (by $\gtrsim 40\%$), when the correction factor $1/(1-R)$ is not applied. The calculated values of R, namely $R_{3d} = +0.178$ (shielding) and $R_{4p} = -0.175$ (antishielding), bring the two corrected values of Q into very good agreement. We thus obtain $Q(^{63}Cu) = (-0.195 \pm 0.004) \times 10^{-24}$ cm^2. Besides the work on Cu 3d and 4p, the following calculations have also been carried out: (1) R_{5d} for the 5d states of Pr and Tm; (2) R_{2p} and R_{3p} for the 2p and 3p states of Li; (3) R_{2p} for the 2s2p ^3P excited state of beryllium. (auth)

5071 OPTICAL EMISSION PRODUCED BY PROTON AND HYDROGEN-ATOM IMPACT ON NITROGEN. Dahlberg, Duane A.; Anderson, D. Kent; Dayton, Irving E. (Montana State Univ., Bozeman). Phys. Rev., 164: 20-31(Dec. 5, 1967).

Optical emissions produced in collisions of protons and hydrogen atoms incident on nitrogen molecules were studied in the spectral region from 1200 to 6000 Å. Relative emission cross sections were measured in the energy range from 10 to 130 keV. The prominent features of the nitrogen spectrum below 2000 Å were the Lyman-α line and atomic nitrogen lines. The Lyman–Birge–Hopfield system appeared also, but it was weak. At the longer wavelengths, the N_2^+ first negative and the N_2 second positive systems dominated the spectrum. Relative emission cross sections for the production of the first negative bands in collisions of hydrogen atoms with nitrogen molecules were nearly constant as a function of energy, and at an energy of 40 keV the cross section was one-half as large as the cross section for proton collisions. The cross section for the second positive band due to hydrogen-atom impact was about 3×10^{-18} cm^2 at 25 keV, whereas for proton impact the cross section was about 2×10^{-19} cm^2 at its maximum value. The cross sections for the atomic nitrogen lines produced in hydrogen-atom impact were approximately 75% of the cross sections for the same lines produced in proton impact. Hydrogen-atom collisions had higher cross sections throughout the energy range for the production of Lyman-α emission. (auth)

5072 THEORY OF WEAK ATOMIC AND MOLECULAR INTERACTIONS. Musher, J. I.; Amos, A. T. (Yeshiva Univ., New York). Phys. Rev., 164: 31-43(Dec. 5, 1967).

A new perturbation procedure for calculating interatomic interaction energies in which the wave function is expanded in terms of product functions is presented. The method is used to discuss various difficulties which can arise in such calculations and these are illustrated by considering the problem of the interaction of two hydrogen atoms. It is found that (a) the inclusion of continuum states in the basis set of functions is of vital importance; (b) the inclusion of charge-transfer states or of antisymmetrical product functions in the basis set can lead to ambiguous results; (c) in general, exchange integrals cannot be neglected relative to Coulomb integrals; and (d) only when the basis functions are products of the individual atomic wave functions is it possible to make a priori estimates of the magnitudes of the higher-order terms in the perturbation expansion. (auth)

5073 LIFETIME OF THE FIRST EXCITED ATOMIC STATES OF ^{87}Rb. Feichtner, John D.; Gallagher, Joe H.; Mizushima, Masataka (Univ. of Colorado, Boulder). Phys. Rev., 164: 44-8 (Dec. 5, 1967).

The Hanle effect on the resonance lines of the ^{87}Rb atom has been observed. The line shape of the signal for the $5^2S_{\frac{1}{2}} \rightarrow 5^2P_{\frac{1}{2}}$ is found to be Lorentzian, while that for the $5^2S_{\frac{1}{2}} \rightarrow 5^2P_{\frac{3}{2}}$ is dispersion-type. The half-width of these lines was observed to be 3.146 ± 0.13 G and 23.0 G ± 5%, respectively. These values yield the lifetime of $(2.71 \pm 0.14) \times 10^{-8}$ sec and $(3.0 \pm 0.3) \times 10^{-8}$ sec for the $5^2P_{\frac{1}{2}}$ and $5^2P_{\frac{3}{2}}$ states, respectively. The oscillator strengths for the corresponding transitions are found to be 0.673 ± 0.03 and 0.32 ± 0.03, respectively. When the temperature of the scattering cell was changed from 0 to 36°C, an apparent increase of the linewidth at higher temperature was observed. This effect has been explained as a magnetic-field dependent radiative transfer effect at optical depth of the order of the scattering cell dimensions. When the data were analyzed with such an effect included, the reduced Hanle signal showed no temperature dependence of the half-width. (auth)

5074 RELATIVISTIC EFFECTS IN THE EXCITATION OF TRIPLET HELIUM STATES BY ELECTRONS. Mittleman, Marvin H. (Univ. of California, Berkeley). Phys. Rev., 164: 48-50(Dec. 5, 1967).

The excitation of triplet He states is a pure rearrangement collision provided that spin-dependent potentials are neglected. The high-energy behavior of this rearrangement cross section is proportional to E^{-3}. If relativistic spin–other-orbit terms are admitted, they produce contributions to the cross section which go to a constant at moderately high energies. These new terms are incoherent with the old ones and have a relative coefficient of α_F^4, where α_F is the fine-structure constant. They become significant at an incident energy of about 8 keV and so are not presently observable. Part of the result obtained here also applies to the case where the incident particle is a proton. (auth)

5075 CLASSICAL CALCULATIONS ON ELECTRON CAPTURE FROM ATOMIC NITROGEN AND OXYGEN. Mapleton, Robert A. (Cambridge Research Labs., Bedford, Mass.). Phys. Rev., 164: 51-5(Dec. 5, 1967).

Approximate total cross sections are calculated for the processes $H^+ + A \rightarrow H + A^+$, A = N, O, $He^{++} + N \rightarrow He^+ + N^+$, using the classical theory of electron capture developed by Bates and Mapleton. In the case of capture by protons (H^+) for impact energies from 30 keV to 4 MeV, the calculated cross sections agree rather well with the corresponding measured values per gas atom for capture from N_2 and O_2. According to this classical model, capture from the 2s subshells of O and N each contributes appreciably for

most impact energies, with 2s-orbital capture dominating 2p capture above 2 MeV, similarly to quantum-mechanical estimates. Although calculated cross sections for capture from N by α particles (He^{++}) are compared with the corresponding measured values per gas atom for capture from N_2, these measured values occur at impact velocities where the theory is not applicable. (auth)

5076 TOTAL CROSS SECTIONS FOR INELASTIC SCATTERING OF CHARGED PARTICLES BY ATOMS AND MOLECULES. I. A SUM RULE FOR THE BETHE CROSS SECTIONS AND ITS APPLICATION TO THE HELIUM ATOM. Inokuti, Mitio; Kim, Yong-ki; Platzman, Robert L. (Argonne National Lab., Ill.). Phys. Rev., 164: 55-61(Dec. 5, 1967).

The Bethe cross section for inelastic scattering of fast charged particles by an atom or molecule is shown to obey a sum rule which permits the calculation of the total inelastic scattering cross section from the optical oscillator strength distribution and certain ground-state expectation values. The sum rule can also be utilized as a requirement of compatibility among the individual inelastic scattering cross sections; for example, together with the experimental ionization cross section, it yields the total cross section, which is very poorly known at the present time. An accurate evaluation is made for the helium atom. The resulting total inelastic scattering cross section is in excellent agreement with experimental data. (auth)

5077 LOW-FIELD DRIFT VELOCITIES AND REACTIONS OF NITROGEN IONS IN NITROGEN. McKnight, L. G.; McAfee, K. B.; Sipler, D. P. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 164: 62-70(Dec. 5, 1967).

Drift velocities and reactions of nitrogen ions have been investigated at 300°K at values of E/N (the ratios of electric field to number density) between 1.5 and 20×10^{-16} V cm^2, and at pressures between 0.5 and 1 torr. Ions were produced in a glow discharge and were gated into a drift cell, withdrawn through a slit, and their mass and intensity were determined as a function of the drift time by a mass analyzer. Comparison of experimental results with theoretical calculations allowed the determination of true drift velocities and reaction rates for ions undergoing reaction during the drift time. The ions in nitrogen were found to occur in two groups, $N_2^+ - N_4^+$ and $N^+ - N_3^+$, such that interactions within the groups are much faster than any interactions between the groups. Rate constants for the reaction $N_2^+ + N_2 + N_2 \rightarrow N_4^+ + N_2$ were found to vary from 7×10^{-29} to 2×10^{-29} cm^6/sec between E/N of 5×10^{-16} and 18×10^{-16} V cm^2, while for the reverse reaction the rates varied from 0.3×10^{-13} to 110×10^{-13} cm/sec. The pressure dependences of the reaction rates were consistent with a three-body forward reaction and a two-body reverse reaction over our limited pressure range. For the $N^+ - N_3^+$ system, the interaction of N^+ with the neutral gas to produce N_3^+ was observed at E/N = 5×10^{-16} V cm^2 with a rate constant of 3×10^{-29} cm^6/sec. No reactions could be positively identified which produced N^+ over the range of our experimental parameters. (auth)

5078 INTERPRETATION OF ION-MOBILITY EXPERIMENTS IN REACTING SYSTEMS. Edelson, D.; Morrison, J. A.; McKnight, L. G.; Sipler, D. P. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 164: 71-5(Dec. 5, 1967).

The Tyndall drift-tube experiment with a pulsed ion source has been analyzed for the case of two ions that interconvert in the drift space. Exact solutions for the relevant differential equations have been obtained. It is shown that when the time constants of the interconversion reactions become commensurate with the ion drift times, the ion velocities are given by the initial and final bounds of the ion-arrival curves for the fast and slow ion, respectively. Peaks which may occur at intermediate times are a consequence of the reacting system and must not be misinterpreted as an ion transit time. It is also shown that the reaction time constants may be extracted from the experimental data, if the analysis is extended to include diffusion and effects of the finite time resolution of the experiment. For this purpose a numerical simulation of the system is required. The relationship between this numerical approach and the analytical solution is demonstrated. (auth)

5079 INTENSITY MODULATION OF TRANSMITTED LIGHT AT THE GROUND-STATE HYPERFINE FREQUENCY OF ^{39}K. Firester, Arthur H.; Carver, Thomas R. (Princeton Univ., N. J.). Phys. Rev., 164: 76-83(Dec. 5, 1967).

Intensity modulation of transmitted light at 462 MHz due to coherence between sublevels of the ^{39}K ground state is discussed. A concise theory of transmitted-light modulation is presented, using the density-matrix and monitoring-operator formalism. The theory and construction of an ultrahigh-frequency photodetection system is described. The auxiliary apparatus is also described, together with experimental conditions under which signals have been observed. It is suggested that a possible application of this technique is a wide-range magnetometer. (auth)

5080 SPECTRAL LINE SHAPE IN THE PRESENCE OF WEAK COLLISIONS AND INTENSE FIELDS. Lambropoulos, P. (Bendix Corp., Southfield, Mich.). Phys. Rev., 164: 84-93(Dec. 5, 1967).

A general treatment of the resolvent operator in Liouville space using the Goldberger–Watson approach is presented. Exact, formal expressions for the matrix elements of the resolvent, as well as approximate expressions based on an iteration procedure, are given. The formalism is then applied to the study of the line shape of atomic transitions in the presence of both weak collisions and an intense radiation field. The dependence of the line shape on the intensity and spectral composition of the field is discussed, and expressions for shifts and widths are derived. (auth)

5081 RADIATIVE LIFETIMES OF EXCITED ELECTRONIC STATES IN IONIC SPECIES OF NITROGEN. Lewis, Myron R. (Panametrics, Inc., Waltham, Mass.); Marshall, Theodore; Carnevale, Edmund H.; Zimnoch, Frederick S.; Wares, Gordon W. Phys. Rev., 164: 94-103(Dec. 5, 1967).

The foil excitation technique, wherein a high-energy (2-MeV) beam of ions is passed through a thin (~1000 Å) carbon foil, has been used to measure lifetimes of excited electronic states in nitrogen II through V. The lifetimes were obtained by measuring the decay of optical radiation as a function of distance from the foil. The excited states were considerably above the ground state of the particular ion, and as a consequence, nonlinear population by cascading was minimal. Because of the low speed of the optical system (f/8.8), only the most intense multiplets and members of multiplets were observed. The wavelength range in which transitions were observed was 2000 to 5000 Å. The lifetimes measured were between 0.4 and 10 nsec. In general, these lifetimes apply to all the members of the multiplet, since the levels of origin as well as the levels of termination are closely spaced with respect to the total-angular-momentum quantum number J. Where it is possible, these lifetimes are compared with available calculations. Some transitions are untabulated and were identified through the use of a computer program. (auth)

5082 K-, L-, AND M-SHELL ATOMIC PHOTOEFFECT FOR SCREENED-POTENTIAL MODELS. Schmickley, R. D. (Lockheed Research Lab., Palo Alto, Calif.); Pratt, R. H. Contract AF49(638)-1389. Phys. Rev., 164: 104-16(Dec. 5, 1967).

Photoelectric cross sections for K through M_V subshells of iron, tin, and uranium have been numerically computed for x rays from 412 to 1332 keV using a relativistic multipole expansion of the matrix element. Electronic orbitals and partial waves were computed in the central-field approximation. Comparison of screened with unscreened results shows that angular distributions and polarization correlations are essentially unaffected by central-potential screening; total cross sections are merely renormalized by a factor equal to the square of the ratio of screened to Coulomb bound-state normalizations. This normalization effect is used to develop a table of realistic total cross sections for energies 10 to 3000 keV, and atoms Z = 13 through 92. These predictions are compared with existing experimental data. (auth)

5083 ABSOLUTE MEASUREMENTS OF THE 2^1P AND 2^3P ELECTRON EXCITATION CROSS SECTIONS OF HELIUM ATOMS. Jobe, John D.; St. John, Robert M. (Univ. of Oklahoma, Norman). Phys. Rev., 164: 117-21(Dec. 5, 1967).

The apparent cross sections for electron excitation of the 2^1P and 2^3P states of helium are examined in the light of new and detailed information concerning the cascading to these levels from higher states, particularly in the low-energy region near onset. Excitation functions of the ^{1}S, ^{1}D, ^{3}S, and ^{3}D states from n = 3 to n = 7 or 8 are presented in this energy range. Absolute measurements of the apparent cross sections of 22 of these states are also given. Excitation functions for the 2P states are presented for low-energy and extended-energy ranges. After allowance is made for imprisonment in the 2^1P state, the cascading corrections yield the cross sections for direct electron excitation to the 2^1P and 2^3P states over the energy range from onset to 450 eV. The maximum value for the 2^1P state is 9.2×10^{-18} cm^2, and for the 2^3P state is 2.2×10^{-18} cm^2. The results show good agreement with theoretical calculations for energies greater than 100 eV, but poor agreement in the low-energy range. (auth)

5084 THEORY OF ELECTRON IMPACT EXCITATION AND IONIZATION OF ATOMS AND IONS. Kang, Ik-ju; Foland, William D. (Univ. of Massachusetts, Amherst). Phys. Rev., 164: 122-30(Dec. 5, 1967).

A theory of inelastic processes of electron-hydrogen and electron-ion collisions is formulated along the Gell-Mann–Goldberger

approach describing all electrons by the eigenstates of the same Hamiltonian and satisfying the Pauli principle. It is found that this approach is satisfactory conceptually in that orthogonality between the initial and the final states is preserved, the boundary condition is met, the completeness relation for the unperturbed wave functions exists, and the unitarity of the scattering matrix is preserved. The conventional formalisms are also discussed with respect to these matters. Two consequences of the formulation—a finite-threshold law for excitations and the linear-threshold law, in energy, for ionization—are derived. It is shown that also obtaining are an Ochkur-like relation for excitation and the Peterkop relation for ionization. Furthermore, the theory is extended to cases of many-electron atoms and ions for which the same threshold laws are obtained. Finally, a theorem which is an essential assumption if the impulse approximation is proved, and the validity of the present formalism is noted. (auth)

5085 MOLECULAR WAVE FUNCTIONS AND INELASTIC ATOMIC COLLISIONS. Lichten, William (Yale Univ., New Haven). Phys. Rev., 164: 134-42(Dec. 5, 1967).

A theoretical interpretation is given of inelastic atomic collisions, especially violent cases where the atomic electron shells deeply interpenetrate. The basis set consists of a product of single-particle, hydrogen-molecular-ion orbital wave functions. The occurrence of large energy losses at critical internuclear distances can be seen as a result of the promotion of inner-shell electrons predicted by molecular-orbital (MO) theory. Energy losses, multiple ionization and fast-electron ejection happen as a result of transitions between MO single-particle energy levels at crossings. A list is given of the mechanisms which cause an avoidance of diabatic crossings. After the collision, the atoms are left in narrow, discrete states with several electrons simultaneously, highly excited. This type of excitation occurs in heavy-particle collisions or in nuclear fission, but not in photon or electron bombardment. The presence of fast electrons at definite energies is seen as a unique prediction of the present model. The lack of correlation between the charge states of the separating atoms after the collision is seen to result from the weakness of correlation energy among electrons in highly excited, outer shells. The consistency of the MO model with the details of energy losses, fast-electron spectra, and positions of critical internuclear distances indicates the insufficiency of purely statistical models and the lack of necessity of the assumption of plasma oscillations or other ad hoc mechanisms. A noteworthy feature of this analysis is that the Born–Oppenheimer approximation has been extended to collisions which involve nuclear kinetic energies of several hundred kV. (auth)

5086 FORMATION OF EXCITED STATES IN A HELIUM TARGET BY THE IMPACT OF 0.15- TO 1.0-MeV PROTONS AND DEUTERONS. I. EXPERIMENTAL. Thomas, E. W.; Bent, G. D. (Georgia Inst. of Tech., Atlanta). Phys. Rev., 164: 143-50(Dec. 5, 1967). (ORO-2591-28).

An optical technique has been used to determine the absolute cross sections for the excitation of various n^1S, n^1P, and n^1D states of neutral helium by the impact of 0.15- to 1-MeV protons on a low-pressure gaseous helium target. The emission resulting from the radiative decay of collisionally excited atoms is analyzed using an optical spectrometer, and detected by a low-noise photomultiplier. The absolute photon-detection efficiency of the system is determined with the aid of a tungsten-strip-filament lamp of known emissive power. It is shown how the rate of emission of photons may be related to the cross section for exciting the parent level in terms of known transition probabilities. Cross sections for the formation of various singlet excited states of helium by proton bombardment are presented as a function of projectile energy. Deuterons were used to extend the effective velocity range of the data in selected cases. The cross sections for the formation of the ^1S and ^1D states by excitation from the ground state show a rapid decrease with increasing projectile velocity. The ^1P-state excitation-cross sections peak at about 120 keV and fall off slowly with further increase of projectile energy. Data are also presented for the emission of the He II (4 → 3) transition induced by proton impact. Systematic discrepancies between previously published sets of data are identified as being caused by differences in the calibration of detector sensitivity. (auth)

5087 CROSS SECTIONS FOR THE FORMATION OF EXCITED STATES IN A HELIUM TARGET BY THE IMPACT OF 0.15- TO 1.0-MeV PROTONS. II. COMPARISON WITH THEORY. Thomas, E. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., 164: 151-5(Dec. 5, 1967). (ORO-2591-29).

Experimental data on the excitation of helium by the impact of protons in the energy range 0.15 to 1.0 MeV, published in the preceding paper, are compared with available theoretical predictions. The general predictions of the Bethe–Born approximation are examined, and empirical values are determined for the constants in the equations which will allow the prediction of the behavior to be expected at higher energies and for different projectiles. In the case of quadrupole transitions, the accuracy of available Born-approximation predictions is poor, but reasonable agreement is found with the experimental data. Accurate calculations in the distortion approximation are available for the excitation of dipole transitions, and these are found to agree very well with experiment down to 75-keV impact energy. The data for the simultaneous removal of one electron and the excitation of the remaining electron are examined qualitatively in the light of theoretical predictions and compared with other two-electron excitation processes. (auth)

5088 ELECTRON CAPTURE AND EXCITATION IN He^+–He COLLISIONS. Sural, D. P. (Jadavpur Univ., Calcutta); Mukherjee, S. C.; Sil, N. C. Phys. Rev., 164: 156-65(Dec. 5, 1967).

The processes of excitation and capture of electrons in He^+–He collisions have been theoretically investigated. An expansion in terms of products of atomic wavefunctions has been used which takes account of the possibilities of the excitation of the helium atom to the 2^1S and 2^3S states and the capture of an electron into the ground, 2^1S, and 2^3S states. The probabilities for the different processes have been computed for several impact parameters over the energy range 0.6 to 40 keV. The calculated total cross sections for excitation to and capture into either of the above excited states in the above-mentioned energy range are found to be almost equal. The sum of the calculated total cross sections for electron capture in the ground, 2^1S, and 2^3S states of helium agrees fairly well with experimental results. (auth)

5089 ELECTRON CAPTURE INTO THE 4s STATE OF H BY FAST H^+ IMPACT ON GASES. Hughes, R. H.; Dawson, H. R.; Doughty, B. M. (Univ. of Arkansas, Fayetteville). Phys. Rev., 164: 166-70(Dec. 5, 1967).

Cross sections have been determined for electron capture into the 4s state of atomic hydrogen by fast-proton (5 to 120-keV) impact on He, Ar, Ne, N_2, H_2, and O_2. Some improved measurements are reported on previously published cross sections for electron capture into the 3s state of atomic hydrogen for fast-proton impact on these gases. Above 80 keV, the cross sections for capture into the 3s and 4s states appear to be proportional to n^{-3}, where n is the principal quantum number of the final state. Secondary structure appears in the 3s and 4s excitation functions for impact on the heavier gases (Ar, Ne, N_2, and O_2) below 7 keV. (auth)

5090 STUDY OF INNER-ELECTRON EXCITATIONS IN ALKALI HALIDE MOLECULES BY 25-keV ELECTRON IMPACT SPECTROSCOPY. Geiger, J.; Pfeiffer, H.-Chr. (Technische Univ., Berlin). Z. Phys., 208: 105-12(1968). (In German).

The energy-loss spectra of 25-keV electrons after interaction with alkali halide vapors were measured. For the energy losses in the energy range $E \leq 6$ eV the positions of the peaks are consistent with light absorption measurements considering the energy resolution of the loss spectra. At higher energy peaks were observed, which correspond to the excitation of inner electrons belonging to the alkali atoms. From electron-diffraction diagrams it follows, that for the lithium halides the concentration of dimers is considerable. (auth)

5091 POLARIZATION OF SLOW ELECTRONS (100 TO 2000 eV) ELASTICALLY SCATTERED FROM HEAVY ATOMS. Buehring, Wolfgang (Univ., Heidelberg). Z. Phys., 208: 286-98(1968).

The angular and energy dependence of the Mott polarization for slow electrons is explained in terms of the complex zeros of the scattering amplitude f(z), where z is the cosine of the scattering angle. The trajectories in the complex z plane, on which the zeros move if the energy is varied, are shown in the case of scattering from mercury atoms. The properties of these trajectories imply that there are, in fact, certain combinations of energy and angle for which total polarization occurs. Calculations for target atoms lighter than mercury show that the number of such combinations becomes smaller and the corresponding energy values are shifted to lower energies. The possibility is also discussed to extract the complex zeros and the other relevant parameters from the experimental data rather than from theoretical calculations, which to some extent are sensitive to the model of the atomic potential. (auth)

5092 TOTAL SCATTERING CROSS SECTIONS FOR COLLISIONS OF H_2, D_2, AND He WITH THE INERT GASES Ne, Ar, Kr, AND Xe IN THE THERMAL ENERGY RANGE. Helbing, R.; Gaide, W.; Pauly, H. (Univ., Bonn). Z. Phys., 208: 215-33 (1968). (In German).

The velocity dependence of the total elastic cross section has

been measured for the scattering of H_2, D_2, and He beams by Ne, Ar, Kr, and Xe gases. Velocity-selected beams were attenuated by gas in a scattering chamber. A universal detector, with a magnetic mass separator, was used in conjunction with lock-in techniques. The results are compared with quantum mechanical calculations using a Lennard-Jones 12–6 potential, and employing suitable averaging over experimental velocity distributions. Potential parameters are presented. These are in good agreement with those expected from other methods of measurement. (auth)

5093 SPECTRUM OF DOUBLY IONIZED LANTHANUM (La III). Odabasi, Halis (Univ. of Colorado, Boulder). J. Opt. Soc. Amer., 57: 1459-63(Dec. 1967).

Sixty-five new spectral lines of doubly ionized lanthanum in the interval from 2000 to 12,000 Å are reported. Four newly discovered terms (10s, 9p, 9d, 9f) are given. Fine-structure splittings of 5g, 6g, 7g, and 8g terms are determined, and their peculiar behavior is discussed. The hyperfine structure of the $6s\ ^3S_1$ level is $1.03 \pm 0.10\ cm^{-1}$. By using the new terms, the previously reported ionization energy is corrected to $154{,}664 \pm 15\ cm^{-1}$. The theoretical values of spin–orbit coupling constants are calculated for the first three elements of the Cs isoelectronic sequence. (auth)

5094 ANGULAR ACCEPTANCE OF A QUADRUPOLAR MULTIPLET. Regenstreif, Edouard (Univ., Rennes, France). Compt. Rend., Ser. A and B, 265: 351-4(Aug. 1967). (In French).

A simple formula is proposed for the calculation of the angular acceptance of a quadrupole multiplet with alternate gradients. (tr-auth)

5095 THEORY OF THE SYMMETRICAL QUADRUPOLE TRIPLET WITH ALTERNATE GRADIENTS. Regenstreif, Edouard (Univ., Rennes, France). Compt. Rend., Ser. A and B, 265: 234-7(July 24, 1967). (In French).

The results obtained previously (Compt. Rend., Ser. B, 263: 1205 (1966)) are applied to the study of the symmetric triplet composed of quadrupole lenses. (tr-auth)

5096 PRECISION DETERMINATION OF H/E FROM THE ELECTRON ENERGY-LOSS SPECTRUM OF He. Geiger, J.; Schroeder, B. (Technische Univ., Berlin). Naturwissenschaften, 54: 439(Aug. 1967). (In German).

The value h/e of the electron energy-loss spectrum of He was measured using a high-resolution electron spectrometer with an electron monochromator. The value 1.37919 ± 0.0008 electrostatic units was obtained. The uncertainty in the potential determination was a maximum of 60 ppM. This value was compared with previous results. (J.S.R.)

5097 THE EFFECT OF MAGNETIC TRANSFORMATIONS ON THE γ ANGULAR DISTRIBUTION OF GAMMA QUANTA DURING ANNIHILATION OF POSITRONS BY ELECTRONS IN FERROMAGNETICS. Dekhtyar, I. Ya.; Mikhalenkov, V. S.; Sakharova, S. G. (Inst. of Metal Physics, Kiev). Dokl. Akad. Nauk SSSR, 174: 803-6(June 1, 1967). (In Russian).

Two series of materials were chosen to investigate the above effect: (a) Gd, Fe_2Pt, 64% Fe + 31% Ni + 5% Co and Ni + 30% Cu, possessing a positive magnetostriction ($\lambda_s > 0$), and (b) nickel and its alloys containing 10 and 40% copper, possessing a negative magnetostriction ($\lambda_s < 0$). The initial samples had been annealed at 800 to 900°C for three hours in vacuum. The angular distribution of gamma quanta was determined above and below the curie point, which corresponded to the paramagnetic and ferromagnetic state of the metal. The observed change in rate of positron annihilations by electrons was due to volume changes during the magnetic transformation, and was not due to a change in the half-life of the positron. The metal surface represented a potential barrier whose transparency to positrons was different in the ferromagnetic and paramagnetic states. On going from the paramagnetic to the ferromagnetic state the change in positron annihilation count rate was positive for alloys having a positive magnetostriction, and negative or close to zero for alloys with a negative magnetostriction. (TTT)

5098 FOCUSING OF THERMAL BEAMS OF HYDROGEN ATOMS AND OPTIMIZATION OF THE PARAMETERS OF A HYDROGEN ATOMIC BEAM OSCILLATOR. Livshits, A. I. (Electrotechnical Inst. of Communications, Leningrad). Zh. Tekh. Fiz., 37: 1304-13(July 1967). (In Russian).

The author (Zh. Tekh. Fiz., 37: No. 5, 1967) has previously discussed the focusing by a six-pole magnetic lens of a monoenergetic beam of neutral hydrogen atoms issuing from a point source and has developed analogies between the magnetic focusing system and geometric optics. This treatment is extended to the case when the beam is not monoenergetic and issues from a finite orifice. The calculations were undertaken because of their interest in connection with the development of a practical frequency standard based on a hydrogen atomic beam oscillator. Formulas are derived for the focusing of a beam whose energy distribution is proportional to $E^{\frac{1}{2}} \exp(-E/kT)$, where E is the kinetic energy of a hydrogen atom of the beam, T is the temperature, and k is Boltzmann's constant. The effect of preliminary collimation of the beam by a bundle of collimating tubes is discussed and relations between the characteristics of the collimator and the parameters of the magnetic lens for maximum density and minimum size of the focused beam are derived. The results of some numerical calculations are presented and discussed briefly. There is also presented a photograph of a focused hydrogen atom beam. (ATD)

5099 HIGH-VACUUM ION SOURCE WITHOUT FOCUSING FIELDS. Zinchenko, N. S.; Zinchenko, G. N. (Inst. of Radiophysics and Electronics, Kharkov). Zh. Tekh. Fiz., 37: 1258-68(July 1967). (In Russian).

The operating principles of a high-vacuum (10^{-5} mm Hg and less) ion source are presented and a description is given of the experimental setup used. The experimental results are compared with calculated data. The arrangement is based on the focusing of electron beams by positive ions in a retarding electrostatic field and high vacuum. The focusing ions are produced by the shock ionization of the gas atoms or molecules by thesbeam electrons. The retarding field is positioned between the electron accelerator diaphragm and the collector of electrons. The latter has a positive potential below that of the accelerator diaphragm. The arrangement ensures a maximum ion density near the collector. Both electrons and ions move in the same direction and form a common beam. The collector separates the electron from the ions. The latter pass through the collector opening and into an ion trap. The density of ions in the beam and the value of the ion current at the trap are augmented by the stream of secondary electrons knocked out of the collector which moves toward the accelerator diaphragm, creating additional ions on their way. The experimental ionization efficiency was of the order of hundredths and tenths of one percent; the efficiency of the setup one tenth of one percent. There was practically no consumption of gas. These parameters are better than can be obtained in a number of known ion sources. The proposed source is also characterized by simplicity of manipulating the ion current over a wide range by varying the potential of the electron collector. (ATD)

5100 MEASUREMENT OF SHARING OF DISSIPATION ENERGY BY A PRIMARY IN SILICON. de Cosnac, B.; Dulieu, P.; Noel, J.-P. (CEN, Fontenay-aux-Roses, France). Rev. Phys. Appl., Suppl. J. Phys., 2: 158-62(Sept. 1967). (In French).

The sharing of energy dissipation between the atomic lattice and the electrons for silicon ions in silicon was determined experimentally, using a silicon solid-state ionization chamber in which a known spectrum of recoil atoms is produced by irradiation with monoenergetic neutron beams. (auth)

5101 FAST ION SCATTERING AGAINST METAL SURFACES. Snoek, C.; Kistemaker, J. (FOM Laboratorium voor Massascheiding, Amsterdam). Advan. Electron. Electron Phys., 21: 67-99(1965).

The fast emitted and reflected particles, present at ionic bombardment in the energy range of 10 to 100 keV, are discussed. The basic rules governing two-atom collisions are reviewed. Papers dealing with the experiments concerning ionic scattering are covered. The emission of light by ionically bombarded metallic targets is treated. (M.H.R.)

5102 POLARIZATION OF ELECTRON BEAMS AND THE MEASUREMENT OF THE g-FACTOR ANOMALY OF FREE ELECTRONS. Farago, P. S. (Univ. of Edinburgh). Advan. Electron. Electron Phys., 21: 1-66(1965).

The general properties and formal description of polarized electron beams are outlined. The behavior of electrons in macroscopic electromagnetic fields is described. The problems of producing polarized beams particularly at low energies is discussed. Experiments with polarized beams carried out for the high precision measurement of the anomalous magnetic moment of free electrons are described. (M.H.R.)

5103 KINETIC EJECTION OF ELECTRONS FROM SOLIDS. Medved, David B. (Electro-Optical Systems, Inc., Pasadena, Calif.); Strausser, Y. E. Advan. Electron. Electron Phys., 21: 101-79(1965).

The interaction of energetic beams of ions, atoms, and molecules with solids results in a variety of secondary processes. The secondary emission of electrons resulting from such interactions are dealt with here, and more specifically with the case where the

kinetic energy of the impacting particle is a significant variable of the problem. (M.H.R.)

5104 CAPTURE COLLISIONS BETWEEN IONS AND POLAR MOLECULES. Dugan, John V. Jr. (Lewis Research Center, Cleveland); Magee, John L. J. Chem. Phys., 47: 3103-12 (Nov. 1, 1967).

The manner in which a permanent dipole in a molecule affects capture collisions of the molecule with ions is investigated. Analytical capture cross sections are considered, and three cases are distinguished. None of these is strictly applicable to real collisions, but they are useful in establishment of the general magnitudes of cross sections. The Langevin cross section is somewhat of a lower limit. A strict upper limit to the cross section is derived; it depends on the magnitude of the dipole moment. A quantum-mechanical treatment at small relative velocity uses the effective potential of interaction determined by the Stark effect; cross sections for this case depend explicitly on the rotational energy of the polar molecule. Molecules that have a first-order Stark effect have a term ϵ^{-1} in their cross sections, whereas the second-order Stark effect only leads to the $\epsilon^{-\frac{1}{2}}$ term of the Langevin theory (ϵ is the relative translational energy). Numerical cross sections are obtained by using a computer study of collisions. The classical equations of motion are solved. Spiraling collisions (predicted in the Langevin theory) are not obtained, but it is found to be possible to define capture adequately and to set up a procedure for calculation of capture cross sections. This procedure involves averaging initial conditions with proper weighting. The real molecule HCl has been used in the calculations, and the results are compared with experiment as far as possible. A hypothetical molecule with the same dipole moment and polarizability of HCl but with a moment of inertia 100 times larger is also considered. (auth)

5105 TIME-OF-FLIGHT INVESTIGATIONS OF ELECTRON TRANSPORT IN SOME ATOMIC AND MOLECULAR GASES. Wagner, E. B.; Davis, F. J.; Hurst, G. S. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Chem. Phys., 47: 3138-47(Nov. 1, 1967). (ORNL-P-2892).

The time-of-flight (TOF) method for the determination of electron-diffusion coefficients D and drift velocities w described earlier could not be used to investigate a number of gases because a Geiger–Müller counter was used for an electron detector. A new experimental apparatus using differential pumping and an electron-multiplier detector was developed to remove this restriction. This new apparatus was used to measure D and w for He, Ar, H_2, N_2, CO, CO_2, CH_4, and C_2H_4. Considerable divergence of D values from published values by the Townsend method was obtained, indicating a fundamental difference in the methods. (auth)

5106 EXCITATION OF NITROGEN GAS BY FISSION FRAGMENTS ALONG THE ENTIRE TRACK. Sears, John T.; Rodgers, Robert (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 47: 3174-9(Nov. 1, 1967). (BNL-11221).

Luminescence produced in nitrogen in small segments of the tracks of fission fragments was studied with a pulse technique. The amount of formation of the $C^3\pi_u$ state of nitrogen per unit distance, L*, was measured over the entire path length of the low-mass fragment group as a function of track length. The energy loss per unit distance dE/dr can be approximated by L* over the entire fission fragment path length. The observance of light produced from the second positive group ($C^3\pi_u \rightarrow B^3\pi_g$) near the end of the track, despite a major change in the primary mode of energy deposition by the fission fragments, indicates that a more detailed theory of chemical production from the deposition of energy by a heavy charged particle needs to be formulated in the regime of nuclear elastic collisions that exists at the end of the particle's range. (auth)

5107 SINGLE-CONFIGURATION WAVEFUNCTIONS AND POTENTIAL CURVES FOR THE GROUND STATES OF He_2, Ne_2, AND Ar_2. Gilbert, T. L.; Wahl, Arnold C. (Argonne National Lab., Ill.). J. Chem. Phys., 47: 3425-38(Nov. 1, 1967).

Potential energy curves are calculated for He_2, Ne_2, and Ar_2 using single-configuration wave functions constructed from molecular orbitals. In one set of calculations the molecular orbitals are chosen to be a linear combination of Hartree–Fock orbitals of the separated atoms (the LCAO–MO approximation). In another set of calculations SCF molecular orbitals are obtained by the expansion method (the SCF–MO approximation) with basis functions taken from SCF calculations on the separated atoms. SCF–MO's for He_2 are also calculated with basis functions optimized by varying the parameters in the exponents until the total energy is a minimum. Potential curves for these different calculations are compared among themselves and with experiment. (auth)

5108 40-kV ELECTRON SCATTERING FROM Ne, Ar, Kr, AND Xe MEASURED BY THE SECTOR–MICROPHOTOMETER ELECTRON-DIFFRACTION METHOD. Bonham, R. A.; Cox, H. L. Jr. (Indiana Univ., Bloomington). J. Chem. Phys., 47: 3508-17(Nov. 1, 1967).

Experimental differential cross sections for 40-kV electrons scattered by Ne, Ar, Kr, and Xe were measured using the gas electron-diffraction sector–Microphotometer method. Three different camera distances (11, 28, and 62 cm) were used to collect experimental intensity data over a range of the scattering variable s from $s = 0.9$ to $s = 26$. The experimental intensity curves were compared with theoretical intensity curves where the elastic portion of the scattered intensity was calculated using both partial-wave and first Born scattering amplitudes. Hartree–Fock inelastic scattering factors calculated by Tavard were used for the inelastic portion of the scattered intensity, as well as inelastic scattering factors calculated using the plane-wave approximation suggested by Liberman. In the case of Kr and Xe the agreement between the experimental and theoretical intensity curves was better when the partial-wave amplitudes were incorporated in the elastic portion of the intensity than when the first Born amplitudes were used. In the case of Ne and Ar, the difference in the agreement using partial-wave and first Born amplitudes was too small to be significant. The total electronic energies for the atoms studied were also estimated. (auth)

5109 ELASTIC SCATTERING OF LOW-ENERGY ELECTRONS FROM MOLECULAR HYDROGEN. Wilkins, Roger L. (Aerospace Corp., El Segundo, Calif.); Taylor, Howard S. Contracts NSG-616; AF04(695)-1001. J. Chem. Phys., 47: 3532-9 (Nov. 1, 1967).

The cross sections for elastic scattering of low-energy electrons by molecular hydrogen are calculated by solving numerically the continuum Hartree–Fock equations for an electron moving in the potential field of the neutral homonuclear diatomic hydrogen molecule. Hartree–Fock equations make full allowance for electron exchange. The cross sections for elastic scattering of electrons by molecular hydrogen are calculated with and without the inclusion of electron exchange. The agreement in the exchange approximation with experimental data is very good but disappears completely if exchange is neglected. The method of calculation is based on an expansion of the continuum orbitals up to fourth order as a product of a series of spherical harmonics and radial wave functions about the molecular midpoint of the molecule. The potential field of the incident electron due to the nuclei of the neutral molecule is expanded in spherical harmonics up to the eighth order. The continuum orbitals are substituted into the Hartree–Fock equations, integration is performed over angular coordinates, and the resulting infinite set of coupled differential–integral equations is truncated and solved numerically to a self-consistent solution, by an iterative technique for three radial continuum functions. (auth)

5110 PERTURBATION THEORY FOR INTERMOLECULAR INTERACTIONS IN THE WAVE-OPERATOR FORMALISM. van der Avoird, Ad (Battelle Inst., Geneva). J. Chem. Phys., 47: 3649-53(Nov. 1, 1967).

A Schrödinger-type perturbation theory for intermolecular or interatomic interactions is developed in the wave-operator formalism. To include all exchange effects, wave functions are used whose symmetry with respect to permutations of both electronic and nuclear coordinates can be prescribed arbitrarily. This necessitates a modification of the usual perturbation theory. The interaction energy is obtained as a series in ascending powers of the interaction operator. It is proved that every term in this series is real and that the terms of even order are negative definite for perturbation of the ground state. It is verified that up to and including third order the results of this theory, if they are restricted to electron exchange only, agree exactly with those of the Eisenschitz–London theory. (auth)

5111 CERTAIN ATOMIC INTEGRALS FOR CORRELATED WAVEFUNCTIONS. Roberts, P. J. (University Coll., Cardiff, Wales). J. Chem. Phys., 47: 3662-4(Nov. 1, 1967).

Analytical expressions are given for certain three- and four-electron atomic integrals, which contain in their integrands products of Slater-type one-electron functions and inverse first powers of two or three of the interelectronic distances. (auth)

5112 POLAR (VELOCITY–ANGLE) FLUX CONTOUR MAPS FOR KBr FROM THE CROSSED-BEAM REACTIONS K + HBr, DBr: EVIDENCE FOR BOTH FORWARD AND BACKWARD (c.m.) SCATTERING. Riley, Clyde; Gillen, Keith T.; Bernstein, R. B. (Univ. of Wisconsin, Madison). J. Chem. Phys., 47: 3672-4 (Nov. 1, 1967). (COO-1328-22).

New and detailed observations of the velocity and angular dis-

tributions of KBr from the crossed-beam reactions K + HBr and K + DBr are reported. The data are presented in the form of polar (velocity–angle) KBr flux contour maps superimposed upon the nominal velocity vector triangle. The new observations differ from previous observations in ways that indicate more backward (cms) scattering. (A.G.W.)

5113 COMPARISON OF ELECTRON-DIFFRACTION INTENSITY MEASUREMENTS. Bonham, R. A.; Fink, M. (Indiana Univ., Bloomington). J. Chem. Phys., 47: 3676-8(Nov. 1, 1967).

Absolute values of the total electron scattering cross sections for N_2 and O_2 measured using the photographic recording techniques are compared with measurements made using a scintillator with a photomultiplier tube and with calculations based on the independent atom model. The average deviation between the two sets of measurements was around 5%. The two measurements agreed with each other better than with the independent atom model. (A.G.W.)

5114 ATOMIC-SHELL STRUCTURE IN INELASTIC COLLISIONS. Garcia, J. D. (Univ. of Pittsburgh). Contracts DA-31-124-ARO-D-440; NGR-39-011-035. J. Chem. Phys., 47: 3679-80(Nov. 1, 1967).

The classical binary-encounter approximation proposed by Gryzinski is used to investigate ionization of atoms by electron impact. Ionization cross sections for the alkali atoms were calculated, using only delta-function speed distributions. The calculated values agree with experimental values to within a factor of about 2. It was found that the contributions of inner shells increase as the atomic number increases and at K a second maximum in the cross section is produced, which is also observable in Rb and Cs. An expression that can be used to predict the onset of second maxima is proposed. (A.G.W.)

5115 VIBRATIONAL QUENCHING OF GLORY UNDULATIONS IN SCATTERING OF Na FROM POLYATOMIC GASES. Kramer, H. L.; LeBreton, P. R. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 47: 3367-70(Nov. 1, 1967).

The velocity dependence of total cross sections has been measured for the molecular-beam scattering of Na atoms from Ar, Kr, and eight polyatomic gases. The glory undulations observed for Ar and Kr agree well with other recent work. The molecular systems studied fall into three categories with regard to the appearance of undulations: (a) strong: CF_4, SiF_4, C_2F_6, and BF_3; (b) weak: GeH_4, and C_4F_8; and very weak or absent: $C(CH_3)_4$ and CF_3Cl. It seems plausible that damping of the undulations occurs when the polarizability of the molecule changes appreciably during a relatively slow vibration. A semiempirical quench parameter q is defined for molecules of the form AB_n to give a relative measure of the effectiveness of spherically symmetric vibrations in damping the glory undulations. q is proportional to (1) as estimate of the derivative of the polarizability with respect to the symmetric stretching coordinate; (2) a semiclassical measure of the vibration amplitude; and (3) the inverse of the symmetric stretching frequency. The values of q for molecules studied here are in qualitative agreement with the experimental results. (auth)

5116 ITERATIVE QUADRATICALLY CONVERGENT ALGORITHM FOR SOLVING THE GENERAL HARTREE–FOCK–ROOTHAAN EQUATIONS. Wessel, W. Roy (Univ. of Chicago). Contract DA-31-124-ARO-D-447. J. Chem. Phys., 47: 3253-6(Nov. 1, 1967).

A detailed numerical method has been developed for solving the most general case of the Hartree–Fock–Roothaan equations, which arise in the numerical calculation of atomic and molecular wave functions. The method is quadratically convergent and has been tested on a number of practical problems, including the calculation of a Hartree–Fock wave function for the lithium atom and the CN molecule. The generality and reliability of the method are discussed. (auth)

5117 CAPTURE OF THERMAL ELECTRONS BY OXYGEN. Stockdale, J. A.; Christophorou, L. G.; Hurst, G. S. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Chem. Phys., 47: 3267-75(Nov. 1, 1967). (ORNL-P-3033).

Permanent capture of thermal electrons by O_2 to form O_2^- ions requires the participation of a third body in the collision process to provide a dynamical channel for stabilization. The effectiveness of H_2O and C_2H_4 as stabilizing agents in three-($C_2H_4-O_2-H_2O$) and two-($C_2H_4-O_2$) component mixtures has been investigated. The results are analyzed through the following three-body reaction scheme: $e + O_2 + O_2 \xrightarrow{k_1} O_2^- + O_2$ + energy, $e + O_2 + H_2O \xrightarrow{k_2} O_2^- + H_2O$ + energy, and $e + O_2 + C_2H_4 \xrightarrow{k_3} O_2^- + C_2H_4$ + energy; the rate constants k_1, k_2, and k_3 are equal to 0.20 ± 0.02 [J. L. Pack and A. V. Phelps, J. Chem. Phys., 44: 1870 (1966); 45: 4316 (1966)] 1.4 ± 0.5, and $0.34 \pm 0.04 \times 10^{-29}$ cm^6 sec^{-1}, respectively. (auth)

5118 EFFECT OF MOLECULAR ORINETATIONS ON VIBRATIONAL–TRANSLATIONAL ENERGY TRANSFER. Shin, Hyung Kyu (Univ. of Nevada, Reno). J. Chem. Phys., 47: 3302-11(Nov. 1, 1967).

An evaluation of the steric factor $1/Z_0$ for molecule–atom and molecule–molecule collisions has been made for the orientation-dependent Morse potential over the temperature range from 300° to 4000°K. $1/Z_0$ is found to be of the order of 1/3 for H_2-Ar, 1/4 for N_2-Ar, 1/5 for O_2-Ar, 1/7 for Cl_2-Ar, and 1/9 for I_2-Ar at ordinary temperatures. $1/Z_0$ for molecule–molecule collisions is very small compared to these values; it is of the order of 1/20 for H_2-H_2, 1/25 for N_2-N_2, 1/30 for O_2-O_2, 1/50 for Cl_2-Cl_2, and 1/55 for I_2-I_2. A moderately important temperature dependence of $1/Z_0$ is found. In the calculation of $1/Z_0$ the importance of attractive forces and used realistic exponential range parameters is explicitly considered. The temperature dependence of the parameter is discussed, and it is shown that the serious errors might occur in calculating vibrational transition probabilities if the best-fit parameter to experimental data at a particular temperature is used over a wide temperature range (>1000°). (auth)

5119 ON THE EQUILIBRIUM POPULATION OF THE STATES OF O II. Berg, H. F. (Physikalisches Institut, RWTH, Aachen). Z. Phys., 207: 404-10(1967). (In German).

Experimental results concerning the density-dependent relative populations of two energetically different states of the singly ionized oxygen atom are compared to theory. Opposed to the latter, the experiment gave relative populations consistent with the thermodynamic equilibrium assumption down to electron densities of 10^{16} cm^{-3}. The plasma was produced by a modified T-tube and the measured effect may be a peculiarity of the particular plasma investigated. The conclusion may be drawn that the plasma radiates in thermal equilibrium at much lower densities than theoretically expected. If a theoretical estimate of Griem may be assumed formally correct, a correction factor of the order of ten can be applied. This granted, even the states of doubly ionized species may be assumed to be populated as in thermal equilibrium at densities exceeding 10^{17} cm^{-3}. (auth)

5120 HIGH-FREQUENCY ATOM SOURCE. Valyi, Laszlo KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 15: 251-9(1967). (In Hungarian).

The properties of a source for the production of H atoms by gas discharge with alternating electric field, operating with external electrodes and microcollimator, were investigated by measuring the intensity of the collimated beam as a function of gas pressure and by observing the variations of its width and composition. The intensity of the well-collimated atomic beam obtained with 4-mm-diameter bundle of capillaries is 4×10^{16} atoms/sec. (auth)

5121 INELASTIC SCATTERING OF MEDIUM-ENERGY ELECTRONS IN THE CONTINUOUS-ENERGY-LOSS APPROXIMATION. Ostroukhov, A. A. (Kiev State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 9: 1369-76(Dec. 1967).

Translated from Fiz. Tverd. Tela, 9: 1744-54(June 1967).

An analysis of the dimensions and form of the trajectories of fast electrons in solids has been carried out on the basis of simple probabilistic considerations in the continuous-energy-loss approximation. The probability that an electron traverses a trajectory with a given number of elastic collisions causing scattering through an angle greater than $\pi/2$, the average scattering angle of an electron beam, the average penetration depth, and the average energy loss between two successive elastic collisions have been calculated. All of these quantities and the multiplicity of large-angle scattering have been considered simultaneously in various sections of the electron trajectory. As shown by the results of calculations, the continuous-energy-loss model cannot be used for substances with $Z \gtrsim 30$ in the energy range under consideration. (auth)

5122 X RAYS OBSERVED FROM PLUTONIUM IN THE WAVELENGTH REGION FROM 8 TO 75 A. Hakkila, E. A.; Barker, H. L. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Spectrochim. Acta, Part B, 23: 97-100 (Sept. 1967). (LA-DC-8239).

The wavelengths are reported for nine N-series x rays from plutonium metal in the region from 8 to 75 Å*. Possible transitions for these spectra are suggested on the basis of previously published wavelengths for K-, L- and M-series spectra. (auth)

5123 THE EMISSION SPECTRUM OF THORIUM IN THE 1 TO 2.5 μ REGION. Steers, E. B. M. (Northern Polytechnic, London. Atomic Energy Research Establishment, Harwell, Eng.). Spectrochim. Acta, Part B, 23: 135-66(Nov. 1967).

A list is given of about 1000 Th wavelengths in the region 1 to 2.5 μ; about 800 of these are for newly observed lines, and the remainder are new measurements for known lines. Transitions

are assigned for about 300 lines. About 20 new Th I levels have been found from the infrared data, and revised values for some Th I and Th II levels have been deduced from published visible interferometric wavelengths. (auth)

5124 STUDY BY THE METHOD OF LEVEL GROWTH OF THE HYPERFINE STRUCTURE OF THE 7^3S_1 LEVEL OF ^{199}Hg AND ^{201}Hg. Chantepie, Maurice; Margerie, Jean (Faculte des Sciences, Caen). Compt. Rend., Ser. A and B, 265: 302-5 (July 31, 1967). (In French).

By exciting optically by steps the 7^3S_1 level of the odd isotopes of Hg, a measurement was made by the method of level growth of the values $(A/g_j)_{199} = 10{,}732.7 \pm 1.3$ MHz and $(A/g_j)_{201} = -3{,}968.2 \pm 0.7$ MHz. (tr-auth)

5125 REVIEW OF EXPERIMENTAL METHODS OF ELECTRON BEAM INVESTIGATION. Gorkiewicz, Hanna (Technical Univ. of Warsaw). Przegl. Elektron., 8: 53-67(Feb. 1967). (In Polish).

The two kinds of electron-beam research methods are the direct (measuring the current of the beam) and the indirect (measuring the change of the kinetic energy of the beam into other kinds of energy). It is assumed that no magnetic field acts on the beam and that the beam is one of rotating symmetry. Direct methods: (1) The sliding-diaphragm method entails putting a flat metal diaphragm, generally supplied with an analyzing aperture, into the beam and registering the current of that part of the beam that passes through the opening and reaches the collector. (2) The vibrating-probe method requires setting an analyzing electrode vibrating perpendicular to the beam. (3) The sliding-electron-beam method takes advantage of the deflecting action of an electric and magnetic field to move the beam to an immovable analyzer, which registers the result in the form of an oscillogram. (4) Sorting of electrons is done by an electric field that slows and deflects them. Indirect methods: (1) In the glowing-screen method, a screen of metal or carbon is put in the path of a strong electron beam. The bright spot on the high-temperature screen is a cross section of the beam. (2) In the roentgen method, a thin metal foil is bombarded by an electron beam of a few eV and x rays are produced. (3) The luminescent-screen method depends on changing the kinetic energy of the electrons in a beam of a few hundred microamperes per cm^2 into luminous energy. (4) Photographic plates can be used to determine the extent and form of a beam along its whole flight. (TTT)

5126 NOTE ON THE POSSIBILITY OF ORIENTATING AN ATOM BY SUPERPOSITION OF TWO SEPARATELY NON-ORIENTATING INTERACTIONS, IN PARTICULAR, BY ELECTRON ALIGNMENT AND ANISOTROPIC RELAXATION. Lombardi, Maurice (Faculte des Sciences, Saint-Martin-d'Heres, France). Compt. Rend., Ser. A and B, 265: 191-4(July 17, 1967). (In French).

A study was made to determine in which case the combination of two independent phenomena, each having the alignment symmetry statistically incapable separately of rotating the atom, can create orientation. The calculation of anisotropic relaxation was numerically evaluated and shows that the transfer term is of the same order of magnitude as that of relaxation. Thus, a nonnegligible degree of orientation can be attained in experiments where this relaxation dominates the isotropic evolution causes. (J.S.R.)

5127 ZEEMAN EFFECT IN POSITRONIUM ANNIHILATION AT LOW TEMPERATURES. Sauder, William C.; Deslattes, Richard D. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 71A: 347-53(Sept.-Oct. 1967).

The annihilation of positronium is discussed as a means of obtaining a precise measurement of the Compton wavelength of the electron. In particular the spectral line shape of the annihilation radiation is calculated for positronium thermalized in helium gas cooled to the region of its critical point with an applied magnetic field sufficient to yield a three-photon to two-photon branching ratio of unity for the $^3S_0$ component. Under such conditions the rapid thermalization of the positronium and the long half-life of two-photon decay out of the predominantly triplet state make possible the production of rather narrow spectral distributions. An exact solution of the Zeeman effect in positronium is included. This study suggests that a wavelength determination beyond the one part per million level is attainable within the range of present technology. (auth)

5128 ION SCATTERING BY MOLYBDENUM MONOCRYSTAL SURFACE. Arifov, U. A.; Khadzhimukhamedov, Kh. Kh.; Yunusov, A. I. (Physical-Technical Inst., Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 3, 15-17(1967). (In Russian).

Scattering of alkali metal ions by the (001) face of molybdenum monocrystal at 0.3 to 4 keV and 300°K was studied using an oscillograph with a vacuum of 10^{-7} mm Hg. It was found that the scattering coefficient decreases with increasing ion energy. (R.V.J.)

5129 STUDY OF STABILITY OF THE e^+H SYSTEM BY MEANS OF VARIATION METHOD USING ELECTRON COMPUTER. Arifov, P. U. (Physical-Technical Inst., Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 3, 18-21(1967). (In Russian).

The stability of proton–electron–positron system was studied using variational methods in order to select the most suitable functions for the physical phenomenon. An attempt was made at studying the multiparticle system by a method which minimized the energy functional $E(\psi) = (\int d\tau \psi^* H\psi / \int d\tau \psi^* \psi)$ by means of a specially constructed test function ψ, which represents a certain approximation of the apparent eigenfunction of the ground-state of the system. Moreover, the minimum magnitude obtained of the energy E_{min} expresses the upper limits of the proper energy value of the state. It is suggested that the ground state of the system $p^+e^-e^+$ is an analog to the negative hydrogen ion $p^+e^-e^-$ rather than the helium atom; therefore, for describing the ground state of a positron it would be necessary to use a test function which takes into account the particle coordinate symmetry identical to the charge term as was shown by S. Chandrasekhar (Astrophys. J., 100: 176(1944)) for the negative hydrogen ion. (R.V.J.)

5130 CONTINUUM ABSORPTION COEFFICIENT OF HELIUM AND LITHIUM. Kriener, Heinz; Schlueter, Dieter (Sternwarte Bergedorf, Hamburg). Z. Astrophys., 67: 165-7 (1967). (In German).

The continum absorption coefficient k_λ was calculated in the form of the ξ factor using the quantum defect method with the Schluter procedure. The calculations were made for temperatures from 8,000 to 16,000°K. The results show that the function ξ is temperature dependent especially in the short-wave region. It is also shown that the approximations made by Biberman et al. are not generally valid. (J.S.R.)

5131 CONSTANCY OF THE FUNDAMENTAL ELECTRIC CHARGE. Peres, Asher (Univ. of Maryland, College Park). Phys. Rev. Lett., 19: 1293-4(Nov. 27, 1967).

Gamow suggested earlier that e^2 increases in time, in direct proportion to the age of the Universe. An argument in direct contradiction to this is given. (M.O.W.)

5132 TIME VARIATION OF THE CHARGE OF THE PROTON. Dyson, Freeman J. (Yeshiva Univ., New York). Phys. Rev. Lett., 19: 1291-3(Nov. 27, 1967).

From the terrestrial occurrence of the nuclei ^{187}Re and ^{187}Os, it is deduced that the elementary unit of charge e cannot have varied by as much as one part in 1600 during the history of the earth. (auth)

5133 ON THE USE OF GREEN FUNCTIONS IN ATOMIC AND MOLECULAR CALCULATIONS. I. THE GREEN FUNCTION OF THE HYDROGEN ATOM. Hameka, H. F. (Univ. of Pennsylvania, Philadelphia). J. Chem. Phys., 47: 2728-35 (Oct. 15, 1967).

It is customary to derive the quantum-mechanical theory of quasi-free particles by means of Green-function techniques, making use of the Green function of a free particle. It is pointed out here that similar techniques can be used in atomic and molecular calculations if use is made of the Green function of the hydrogen atom, rather than the Green function of a free particle. The Green function of the hydrogen atom is derived by means of contour integrations in the complex plane, following previous work by Meixner. We also derive a slightly modified Green function which is adapted to perturbation calculations of the ground state. Both of these Green functions are obtained as expansions in terms of spherical harmonics; the radial functions are expressed in terms of confluent hypergeometric functions. (auth)

5134 ELASTIC ELECTRON SCATTERING AMPLITUDES FOR NEUTRAL ATOMS CALCULATED USING THE PARTIAL WAVE METHOD AT 10, 40, 70, AND 100 kV FOR Z = 1 TO Z = 54. Cox, H. L. Jr.; Bonham, R. A. (Indiana Univ., Bloomington). J. Chem. Phys., 47: 2599-2608(Oct. 15, 1967).

Elastic electron scattering amplitudes for neutral atoms were calculated using the partial wave expansion method for 10-, 40-, 70-, and 100-kV incident electrons. The partial wave phase shifts were calculated by numerical integration using the phase amplitude method until the results converged to values obtained using the WKBJ and first Born approximations, which were used in the remainder of the partial wave sum. The static potential field of the target atoms was represented by an analytical expression involving a sum of Yukawa terms. Potential field parameters for the expression were obtained by a least-squares fit of the radial electron distribution function, D(r), using Hartree–Fock and relativistic wavefunctions for all the neutral atoms from Z = 1 to Z = 54. For the smaller atoms from Z = 1 to Z = 21, Clementi

Hartree–Fock wavefunctions were used and for the atoms from Z = 22 to 54 Liberman–Waber–Cromer D(r) curves calculated using the Dirac Hamiltonian incorporating a j–j coupling scheme and the Slater $^2/_3$ approximation in the exchange potential were used. (auth)

5135 GROUND-STATE WAVEFUNCTIONS AND ENERGIES FOR THE HELIUM ISOELECTRONIC SERIES THROUGH Z = 10. Brown, Robert T. (Rice Univ., Houston, Tex.); Fontana, Peter R. Contract AT(11-1)-1112. J. Chem. Phys., 47: 3077-8(Oct. 15, 1967).

The method of configuration interaction with a truncated complete set of functions and one variable scale parameter which was recently applied to the first four members of the helium isoelectronic series has been extended to this series through Z = 10. (M.O.W.)

5136 MUONIUM CHEMISTRY. II. Mobley, R. M.; Amato, J. J.; Hughes, V. W.; Rothberg, J. E.; Thompson, P. A. (Yale Univ., New Haven). J. Chem. Phys., 47: 3074-5(Oct. 15, 1967).

Initial studies of the interactions of muonium with atoms and molecules were reported earlier. Data are reported here on the muon depolarization cross section as a function of static magnetic field and for additional molecules C_2H_4 and NO_2. (M.O.W.)

5137 ENERGIES AND INTENSITIES OF SOME LOW-LYING LEVELS OF TRIVALENT CURIUM. Carnall, W. T. (Argonne National Lab., Ill.). J. Chem. Phys., 47: 3081-2 (Oct. 15, 1967).

It is shown that the interpretation of the broadband centered near 17,000 cm^{-1} as the $J = {}^7/_2$ level in the $5f^7$ configuration is consistent with a predicted energy level scheme for trivalent curium. This predicted scheme was calculated from values for F_2 and ζ, which were obtained by direct extrapolation of the values for these parameters found suitable for the lighter actinides. (M.O.W.)

5138 MAGNETO-ELECTRIC SUSCEPTIBILITIES AND FIELD-INDUCED QUADRUPOLE MOMENTS OF S-STATE ATOMIC SYSTEMS. Lyons, James Dennis. Buffalo, State Univ. of New York, 1967. 157p.

Thesis.

A study is made of the effect on S-state atomic systems of the simultaneous interaction of uniform electric and magnetic fields. It is found that in addition to the conventional magnetic susceptibilities and polarizability terms there exists an interaction term in which the energy depends quadratically on both fields. The coefficient of this term in the energy is defined here as the magnetoelectric susceptibility. The magnetoelectric susceptibilities of a large number of two-, four-, ten-, twelve-, eighteen-, and twenty-electron atomic systems are calculated. Analytical Hartree–Fock wave functions are used. The calculations are carried out using double-perturbation theory within the Hartree–Fock framework. The results show that the energy terms described by the magnetoelectric susceptibilities are of the same order of magnitude as those corresponding to the hyperpolarizabilities. The magnetoelectric susceptibility effect is dependent on the relative orientation of the two fields and its behavior with respect to field orientation is described by a property defined as the anisotropy. It is found that the magnetoelectric susceptibilities of the inert gas isoelectronic series systems are all negative and decrease in magnitude as the fields are rotated from perpendicular to parallel. The alkaline earth systems show considerable variation: some are positive, some are negative, and in some the sign depends upon the relative orientation of the fields. In addition, a calculation of uniform electric field quadrupole polarizabilities and shielding factors is made. These describe distortions in the atomic quadrupole moment and in the field gradient at the nucleus, respectively, in the presence of a uniform external field. It is shown that these distortions are independent of the presence of a gradient in the external field. It is found that in neutral atoms and negative ions the change in the quadrupole moment in the presence of a strong external field is not negligible, though in the multiply ionized systems the effect is much less pronounced. (Disser. Abstr.)

5139 EINFUEHRUNG IN DIE ATOMPHYSIK. (Introduction to Atomic Physics). Finkelnburg, Wolfgang. Berlin, Heidelberg, New York, Springer-Verlag, 1967. 535p. DM 48.–; $12.00.

A text book reporting the basic problems and results of all areas of atomic physics is presented. The primary properties of atoms, ions, electrons, atomic nuclei, and protons are summarized. The characteristics of atomic spectra and atomic structure are given. The quantum mechanical atomic theory is considered in detail. The physics of atomic nuclei and elementary particles, molecular physics, and solid body atomic physics are also examined. (J.S.R.)

5140 MUONIC MOLECULES AND NUCLEON–DEUTERON CAPTURE. Carter, Benjamin Perry. Stanford, Calif., Stanford Univ., 1967. 75p.

Thesis.

Variational wave functions were computed for all S states of muonic molecules involving hydrogen isotopes. Results for the pμd ground state were used to compare nucleon–deuteron capture cross sections with pμd fusion rates. Using the molecular wave functions and the results of muonic molecule experiments, the low energy S-wave cross section is estimated for the reaction $D(p,\gamma)^3He$. The result is in disagreement with measurements in the tens-of-kilovolts region, but is consistent with thermal neutron–deuteron capture data when Coulomb effects are taken into account by means of the usual penetration factor. Finally, the usual assumption that proton–deuteron capture occurs only from the doublet state is re-examined, and it is shown how the doublet and quartet matrix elements could both be determined from a new measurement of the total yield of gamma rays from pμd fusion in liquid hydrogen. (Disser. Abstr.)

5141 INTERACTIONS OF MUONIUM WITH ATOMS AND MOLECULES. Mobley, Richard Morris. New Haven, Yale Univ., 1967. 148p.

Thesis.

The interactions of muonium (μ^+e^-) with other atoms and molecules should be similar to those of hydrogen. With polarized muons from a synchrocyclotron beam stopping in argon gas, polarized muonium is formed. Since the positron from muon decay is emitted preferentially in the direction of the muon spin, it is possible to measure quantities related to the muon polarization using standard particle counting techniques. Two types of measurements have been made to study the interactions of muonium with other molecules admitted to the argon gas. In the first, the quenching of the muonium hyperfine resonance signal is observed as a function of added gas concentration. In the second, the polarization of the muon bound in muonium is measured as a function of time at several values of the added gas concentration and external magnetic field. Using models for the interaction mechanisms which are suggested by analogous interactions of atomic hydrogen, the signal quenching and polarization measurements are related to interaction cross sections. In particular, the results obtained with NO and O_2 as added gases are explained on the basis of an electron spin exchange model. Spin exchange couples the four hyperfine levels of muonium, and a density matrix technique is used to calculate the dependence of the microwave resonance signal on the exchange rate. The results clarify some observations made in low and high field resonance studies. The cross sections obtained are a factor of 3 to 4 smaller than those for spin exchange between hydrogen and NO and O_2. Chemical reactions which result in free radicals containing muonium are postulated for other cases. Depolarization can then occur by hyperfine mixing of the muon and unpaired electron spin states. (Disser. Abstr.)

5142 ATOMIC PROCESSES INVOLVING MUONIUM AND ANTIMUONIUM. Morgan, David Luke Jr. New Haven, Yale Univ., 1967. 296p.

Thesis.

Experimental observation of a weak interaction, H_w, coupling muonium (bound state of μ^+,e^- denoted, M) to antimuonium (bound state of μ^-,e^+ denoted, $\bar{M}$) would be of great significance. Such an interaction would be a neutral current interaction and would imply that in reactions involving muons, a multiplicative law of muon parity conservation applies rather than an additive law of muon number conservation. There are two possible effects of such an interaction. One is that an atom formed initially as M will decay as an atom of $\bar{M}$ with a probability, $P(\bar{M})$. The other is that H_w will cause a shift in the hyperfine levels of muonium in the presence of a magnetic field. The purposes of this dissertation are to calculate reasonably accurate values for $P(\bar{M})$ for the M,$\bar{M}$ system in a vacuum or a gas and to calculate the effect of H_w on the hyperfine levels of the M,$\bar{M}$ system in the presence of a magnetic field. A general Hamiltonian is given which includes H_w, the hyperfine interaction, and the effects of external fields. The eigenstates of the M,$\bar{M}$ system are found and the effect of H_w on the hyperfine levels is determined. The quantity, $P(\bar{M})$, depends upon the matrix elements of H_w between the M and $\bar{M}$ components of the M,$\bar{M}$ system which are calculated. For the M,$\bar{M}$ system in a gas, $P(\bar{M})$ is expressed in terms of quantities relevant to the scattering of M and $\bar{M}$ atoms by a gas atom: the elastic and inelastic scattering cross sections, the forward scattering amplitudes, and a quantity related to the coherence between the scattered M and $\bar{M}$ waves. The energy differences between M and $\bar{M}$ at long range from single atoms of hydrogen and argon are found. The energy difference is important for determining the validity of the derived equations for $P(\bar{M})$. The interatomic potential energies for the pairs, M–H,

$\bar{M}-A$, and $M-A$ are found. Perturbation theory with the application of closure, and formulae for the long-range energy between atoms are used in their determination. The scattering interactions of $\bar{M}-H$, $\bar{M}-A$, and $M-A$ are determined. Values for $P(\bar{M})$ are then found for the $M,\bar{M}$ system in argon and other noble gases. A summary of factors relevant to the experimental detection of the $M \rightarrow \bar{M}$ conversion and of the effect of H_w on the muonium hyperfine structure is given. (Disser. Abstr.)

5143 V INTERNATIONAL CONFERENCE ON THE PHYSICS OF ELECTRONIC AND ATOMIC COLLISIONS, LENINGRAD, USSR, JULY 17–23, 1967. ABSTRACTS OF PAPERS. Flaks, I. P.; Solovyov, E. S. (eds.). Leningrad, Publishing House Nauka, 1967. 683p. (CONF-670702). DTIE.

Abstracts only are given for the papers which were presented at the thirty sessions. (W.D.M.)

5144 ELEKTRONNYE PUCHKI I ELEKTRONNYE PUSHCHKI. (Electron Beams and Electron Guns). Alyamovskii, I. V. Moscow, Izdatel'stvo Sonetskoe Radio, 1966. 456p.

The principal problems of focusing intense electron fluxes are discussed. An extensive analysis is made of the fluxes in the homogeneous, periodic, and reverse magnetic field, in the transitional region of nonhomogeneous magnetic field, and in the collector area. Electron guns producing axially symmetric, band- and tube-like streams, and high-perveance and high-convergence guns are also discussed. Descriptions are given of the electrostatic and ion focusings and design and calculations are included for the most important, from a practical point of view. (R.V.J.)

5145 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON SPECTROSCOPY, BOMBAY, INDIA, JANUARY 9–18, 1967. VOLUME II. Trombay, India, Bhabha Atomic Research Center, 1967. 294p. (CONF-670114-(Vol.II)). DTIE.

Papers relating to the following are included: (1) infrared and Raman spectra and theory of molecular vibrations, (2) radio frequency and microwave spectra including ESR and NMR, and (3) solid-state spectra, lasers, spectral studies of plasmas and other topics. (M.O.W.)

5146 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON SPECTROSCOPY, BOMBAY, INDIA, JANUARY 9–18, 1967. VOLUME I. Trombay, India, Bhabha Atomic Research Center, 1967. 281p. (CONF-670114-(Vol.I)). DTIE.

The included papers relate to (1) spectra of atoms and molecules of astrophysical interest, (2) diatomic spectra, and (3) electronic spectra of polyatomic molecules. (M.O.W.)

5147 ATOMIC SPECTRA. Hindmarsh, W. R. Oxford, Pergamon Press, 1967. 378p.

The subject is treated under the following main headings: spectral lines; spectra from atoms with two valence electrons; fine structure; hyperfine structure; Zeeman effect; radiation from atoms; and width of spectral lines. A total of 17 original papers is also reproduced. (UK)

5148 THEORY OF THE ELECTRIC AND MAGNETIC PROPERTIES OF MOLECULES. Davies, D. W. New York, John Wiley and Sons, Inc., 1967. 294p. $10.00.

The following sections are discussed: quantum-mechanical theories, perturbation and variation methods, electric and magnetic moments, polarizabilities and susceptibilities, spin interactions, and the effect of radiation in electric and magnetic fields. (M.O.W.)

5149 LA STRUCTURE HYPERFINE MAGNETIQUE DES ATOMES ET DES MOLECULES, PARIS, 20–24 JUIN 1966. (Hyperfine Magnetic Structure of Atoms and Molecules Meeting, Paris, June 20–24, 1966). Colloques Internationaux du Centre National de la Recherche Scientifique, No. 164. Paris, Editions du Centre National de la Recherche Scientifique, 1967. 439p. 60 F. (CONF-660604). DTIE.

Fifty-six papers are included. (M.O.W.)

5150 DOUBLE-STREAM INTERACTIONS IN ELECTRON BEAMS AND IN SEMICONDUCTORS. Christensen, Douglas Allen. Salt Lake City, Univ. of Utah, 1967. 168p.

Thesis.

A general mathematical analysis of the propagation and coupling characteristics of the waves in a system of two charged-particle streams is developed. Both of Maxwell's equations are combined with an ac Lorentz force equation describing two moving streams of finite dimension immersed in a magnetic field, and a pair of coupled wave equations for the fields in the system are derived. When the wave equations are uncoupled, expressions for the fields can be obtained. It is then possible to match boundary conditions for specific cases and thus obtain determinantal equations whose solutions yield the propagation and coupling properties of the waves in each case. Since no slow-wave approximation is made, fast waves, cyclotron waves, and space-charge waves are all present in the analysis. Two special examples of double-stream interaction are then considered. First, two thoroughly intermixed electron beams flowing with different dc velocities are examined. The possible wave interactions are determined for the configurations of an infinite double beam, a finite double beam filling a cylindrical waveguide, and a finite double beam only partially filling a cylindrical waveguide. A comparison between the results of the infinite and finite systems reveals the effect of transverse variation on coupling between waves of various types. Also, it is found that due to the presence of a dc magnetic field in the finite systems, there are bands of modes on the dispersion $(\omega-\beta)$ diagram rather than single mode lines. Furthermore, surface waves are predicted on the edge of the beams only partially filling the waveguide. Second, two-stream instabilities in semiconductors, specifically indium antimonide, are investigated. It is found that the hole and electron space-charge waves couple together to provide the possibility of backward-wave oscillations in the crystal. The coupling between the cyclotron waves and between the helicon waves is also examined. Collision and thermal diffusion terms are then added to the basic equations of the analysis, and the effect of these terms on the instability growth rates for the space-charge–space-charge interaction is determined in steps. It is found that by including realistic collisions and thermal diffusion, only the higher-order radial modes still possess positive growth rates, and since the higher-order modes are split away from the zero-magnetic field mode by the action of the dc magnetic field, such a field is needed to maintain two-stream space-charge wave instabilities in a typical InSb crystal. Finally, experimental evidence is given for the observation in the laboratory of microwave instabilities from InSb samples with applied dc electric and magnetic fields. Correspondence between these observations and the theory of this paper is discussed. (Disser. Abstr.)

5151 MOLECULAR BEAMS FROM FREE JETS OF PURE AND MIXED GASES. Abuaf, Nesim. Princeton, N. J., Princeton Univ., 1967. 109p.

Thesis.

The seeded beam technique was used in conjunction with thermal energy addition in a nozzle source beam to produce high-intensity neutral beams in the 1- to 10-eV energy range. Mean molecular velocities and velocity distributions in the free jet expansion were measured experimentally for several gases and gas mixtures. The studies with helium as the carrier gas at high nozzle Reynolds numbers showed that the measured molecular velocities were in agreement with predictions based on continuum isentropic expansion to high Mach numbers. At lower Reynolds numbers the velocities were observed to depart from the continuum predictions due to the development of a velocity slip between the light and heavy species. The results with hydrogen and hydrogen rich mixtures showed that the variation of specific heat with temperature and the incompleteness of rotational relaxation of the hydrogen molecules must be taken into account. Previous measurements of velocity distributions giving the terminal Mach numbers in a free jet of pure argon were extended to a wider range of nozzle Knudsen numbers and to high temperatures. The terminal Mach numbers, characterizing the frozen axial translational temperatures were correlated in terms of nozzle Knudsen number in agreement with previous work. Additional data were obtained for neon and helium. The departure of the helium data from the correlation for argon and neon suggested the possibility of quantum effects becoming appreciable because of the very low temperatures in the jet. The argon velocity distributions, representing the terminal Mach numbers reached in the expansion, observed with argon–helium mixtures for argon concentrations above 10% showed dependence upon the nozzle conditions similar to that for pure argon. At lower concentrations of argon, the presence of helium must be taken into account because the behavior of the experimental results with nozzle conditions was more like that of pure helium. To clarify the nature of free jet expansion and the anisotropy of the temperature field in the axial and radial directions, radial distributions of the intensity of beams extracted from free jets were measured. These distributions could be related to the radial temperature of the jet at the entrance of the skimmer or first beam collimating aperture. The radial temperature was found to vary at small axial distances with the minus four-thirds power of the distance as expected for isentropic expansion. At large axial distances it was found to be inversely proportional to the square of the distance from the nozzle. This behavior at large distances is in agreement with some theoretical treatments of the free jet expansion but in disagreement with others. The variation of the centerline beam intensities with nozzle–skimmer distance and source conditions was investigated and found to confirm previous experimental results. Agreement with the prediction of theory was always within a factor of two and was usually better. (Disser. Abstr.)

5152 ELECTROMAGNETIC SCATTERING. Proceedings of the Second Interdisciplinary Conference on Electromagnetic Scattering held at the University of Massachusetts at Amherst, June 28–30, 1965. Rowell, Robert L.; Stein, Richard S. (eds.). New York, Gordon and Breach Science Publishers, 1967. 858p. $48.00. (CONF-650678). DTIE.

Thirty-nine papers presented at the conference are divided into four sections. The first section is devoted to scattering by discrete particles including nonspherical systems, colloidal spheres and cylinders, and spherically symmetric gas molecules. Determination of the sizes of scattering particles from the observed scattering is considered. The second section includes papers on nonparticulate scattering. The correlation-function approach to scattering by assemblies of molecules, spherulites, polymer solids and gels, and simple liquids is emphasized. In the third section dealing with multiple scattering, the discussion is mostly theoretical, but a few experimental results are reported. The fourth section contains papers on nuclear scattering and the optical model of the nucleus and on the velocity and attenuation of waves in a random medium. An abstract of a paper on atomic scattering is included. (A.G.W.)

Cosmic Radiation

Refer also to abstracts 4442 and 5021.

5153 SYNOPTIC STUDY OF THE ATTENUATION COEFFICIENTS FOR THE COSMIC-RAY NEUTRON MONITORS OF THE IGY NETWORK FROM 1957 TO 1965. Bachelet, F.; Dyring, E.; Iucci, N.; Villoresi, G. (Univ., Rome. Gruppo GIFCO del Consiglio Nazionale delle Ricerche, Rome). Nuovo Cim. (10), 52B: 106-23(Nov. 11, 1967).

The solar-cycle variation of the attenuation coefficient of the intensity recorded by the IGY neutron monitors is synoptically studied by regression analysis on daily data of 21 stations using 3-month periods from 1957 to 1965. A combined technique of reducing and filtering the data is applied before performing the least-square analysis, in order to minimize the influence of primary and instrumental changes and to work towards optimal estimates. Values suitable for appropriate correction of the station data for pressure changes are generally found over the whole range of latitudes, altitudes and times. However, a quantitative estimate of the typical peak-to-peak amplitude of the solar-cycle change is reached only at high latitudes near sea level, where data from several stations under similar geophysical conditions are available and the effect is the largest. Here an average variation of about 4% is obtained, in agreement with an independent estimate of the effect. (auth)

5154 COSMIC-RAY RADIAL DENSITY GRADIENT AND ITS RIGIDITY DEPENDENCE OBSERVED AT SOLAR MINIMUM ON MARINER IV. O'Gallagher, J. J. (Univ. of Chicago). Contracts NASA JPL 950615; AF 49(639)-1642. Astrophys. J., 150: 675-98(Nov. 1967).

The radial intensity gradients for both protons and helium nuclei were measured from the orbit of Earth out to a heliocentric range of 1.56 A.U. on the Mariner IV interplanetary probe in 1965. In the diffusion convection model for solar modulation the inward transport of particles resulting from these gradients is balanced by the outward convection of particles in magnetic irregularities carried by the solar wind so that the diffusion coefficient K, can be determined by these measurements of the gradients and the solar-wind velocity. In this paper the observations of the gradient were extended another decade in magnetic rigidity below the preliminary results already reported, so that the dependence of the diffusion coefficient on particle parameters (magnetic rigidity R and velocity $c\beta$) can be studied over a large range of energies (from 20 MeV to ~10 GeV) which are appreciably affected by solar modulation. It is found that the observations are well described by $K \propto R\beta$ for $R\beta > 0.6$ GV and $K\alpha\beta$ for $R\beta < 0.6$ GV. Furthermore, the dependence of the gradient on R and β is found to be the same as that observed for intensity variations with time in 1965. This suggests that, at least at solar minimum, the dependence of the modulation on magnetic rigidity and velocity is roughly the same throughout the modulating region. The mean gradient for protons in the energy range 20 to 100 MeV is $215 \pm 40\%$ $(A.U.)^{-1}$ and for helium nuclei with energies 100 to 420 MeV/nucleon it is $66 \pm 9\%$ $(A.U.)^{-1}$. The gradient for charged particles of mean magnetic rigidity ~6 GV is $9.0 \pm 1.5\%$ $(A.U.)^{-1}$. The diffusion coefficient along the spiral magnetic lines of force derived from these observed gradients is found to be 3.2×10^{21} cm^2/sec for a particle with $R\beta = 1$ GV. In the diffusion convection model the ratio of the modulated cosmic-ray spectrum $u(R,\beta,r,t)$ to the unmodulated spectrum $u(R,\beta,\infty)$ can be written $\exp[-\eta(r,t)/f(R,\beta)]$, where $f(R,\beta)$ has the same form as $K(R,\beta)$ described above. The observed gradient corresponds to a change in the modulating parameter η of $\Delta\eta = 0.2 \pm 0.05$ GV for a mean change in heliocentric radius $\Delta r = 0.4$ A.U. Comparison of this value of $\Delta\eta$ with estimates of η during 1965 suggests strongly that at solar minimum the galactic spectrum is not significantly modulated beyond ~5 A.U. The measurements were made using a three-element solid-state detector telescope which separately identifies protons and helium nuclei by a simultaneous measurement of their energy loss and range. (auth)

5155 ANALYSIS OF HIGH-ENERGY JET SHOWER, Ja 11. Fujimoto, Roichi; Hasegawa, Shun-ichi (Waseda Univ., Japan). Waseda Daigaku Rikogaku Kenkyusho Hokoku, No. 36, 61-6(Sept. 1966). (In Japanese).

An event Ja 11, found in I.C.E.F. emulsion blocks distributed to Japanese groups, was analyzed. The event is caused by a heavy primary particle of 2×10^{11} eV/nucleon, and consists of many interactions of fragment nucleons as well as of secondary particles. The angular distributions are shown in the form of target diagrams and the log tan θ plot for every observed interaction. The kinematical analysis is made by the new method proposed by the authors. (auth)

5156 γ RADIATION OF THE MOON AND THE COMPOSITION OF LUNAR ROCKS (ACCORDING TO RESULTS OF EXPERIMENT ON THE COSMIC STATION LUNA-10). Vinogradov, A. P.; Surkov, Yu. A.; Chernov, G. M.; Kirnozov, F. F.; Nazarkina, G. B. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 11, 1263-73(Nov. 1967). (In Russian).

By means of a γ spectrometer being set on the automatic lunar station which had been lead out on the orbit of the lunar satellite the intensity and the spectral composition of the lunar rock γ radiation was measured for the first time. As a result of measurements it has been established that the chief part (no less than 90%) of γ radiation of the lunar rocks is conditioned by the interaction of cosmic rays with them. The other part of γ radiation of the lunar surface is believed to pertain to natural radioactive elements being contained in lunar rocks. By their content of natural radioactive elements lunar rocks correspond to terrestrial rocks of basic or ultrabasic composition. The existence of rocks containing natural radioactive elements corresponding to terrestrial rocks of acid composition (of the granite type) has not been detected on the lunar surface. The results of experiment show a difference of average intensity of the natural radioactive element γ radiation over lunar "seas" and lunar "continents." On the basis of the data obtained some assumptions are made concerning the evolution of lunar matter and the composition of lunar rocks. (auth)

5157 THE ENERGY DEPENDENCE OF THE POSITRON–ELECTRON RATIO IN THE PRIMARY COSMIC RADIATION IN 1965. Hartman, R. C. (Univ. of Chicago). Astrophys. J., 150: 371-84(Nov. 1967).

The charge composition of the primary electron component was investigated in the energy range from 200 MeV to 10 BeV with a balloon-borne magnetic spectrometer. The fraction of positrons $N^+/(N^+ + N^-)$ is found to be 0.35 ± 0.10 between 200 and 500 MeV, and decreases to 0.07 ± 0.05 between 2 and 5 BeV. An upper limit of 0.20 is obtained between 5 and 10 BeV. Below 200 MeV the high flux of atmospheric secondary electrons and positrons prevents a determination of the primary positron fraction. The results however indicate the presence of a flux of negative primary electrons between 50 and 200 MeV. (auth)

5158 SOURCE OF NEUTRAL COSMIC-RAY PRIMARIES. van den Bergh, Sidney (Univ. of Toronto). Astrophys. J., 150: L107(Nov. 1967).

Counts of galaxies by Shane and Wirtanen (1967) are compared with the distribution of cosmic-ray tracks projected on the galactic sphere. It is concluded that, within the accuracy of the data, there appears to be no significant correlation between sources of neutral cosmic-ray particles and galaxies in the catalog of Shane and Wirtanen. (W.D.M.)

5159 MEASUREMENTS OF THE LOW-ENERGY COSMIC RADIATION DURING THE SUMMER OF 1966. Badhwar, G. D.; Deney, C. L.; Dennis, B. R.; Kaplon, M. F. (Univ. of Rochester, N. Y.). Phys. Rev., 163: 1327-42(Nov. 25, 1967).

The results obtained during two balloon flights of a counter telescope designed to measure the composition of low-energy cosmic rays are presented. The telescope consists of two $\frac{1}{4}$-in.-thick plastic scintillators used to measure dE/dx, followed by a 5-in.-thick crystal of NaI(Tl) to measure the residual energy E of stopping particles. From these measurements the charge and the mass of each particle are calculated. The accuracy of the measure-

ments is sufficient to separate the isotopes of hydrogen and helium and to identify the nuclei of elements up to oxygen. The detector system was flown from Fort Churchill, Canada to a residual atmospheric depth of 2.3 g/cm² for a total of 25 hours in July and August 1966. The differential energy spectra from 60 to 220 MeV/nucleon for protons, deuterons, ^{3}He, and ^{4}He are presented after correcting for the effects of the overlying atmosphere. From these spectra the proton/^{4}He ratio is 4.3 ± 1.0 over the full energy range, while an upper limit on the deuteron/^{4}He ratio of 0.25 has been set at 150 MeV/nucleon. The latter ratio corresponds to a traversal of less than 6 g/cm² of interstellar hydrogen by the cosmic rays. The ^{3}He/(^{3}He + ^{4}He) ratio obtained is 0.094 ± 0.017 in the energy interval from 78–220 MeV/nucleon. The effects of the solar modulation on the proton and helium spectra have been considered by comparing the present data with previous measurements. This comparison is consistent with a modulation function proportional to either $R\beta$ or R. The demodulated ^{3}He/(^{3}He + ^{4}He) ratio is consistent with a traversal of 2.7 ± 0.5 g/cm² of interstellar gas, as calculated using a simple "slab" model, and is also consistent with a model in which a distribution of path lengths is considered. (auth)

5160 MEASUREMENTS ON THE SOLAR MODULATION OF GALACTIC ELECTRONS AND PROTONS IN THE ENERGY RANGE 70 MeV TO 2 bev. Webber, William R. (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 72: 5949-56(Dec. 1, 1967).

On balloon flights made in 1965 and 1966, at Fort Churchill, Canada, a decrease of 20% at high energies to more than 40% at low energies was measured in the intensities of primary cosmic-ray electrons and protons in the energy range 70 MeV to 2 BeV. This decrease occurred in conjunction with a 3.6% decrease in the high-latitude neutron monitor rate at the times of the flights. These decreases are apparently related to the onset of long-term solar modulation effects in the new sunspot cycle. From a study of the fractional change of electron and proton intensities as a function of energy it is possible to conclude that: (1) the electron and proton modulations have approximately the same magnitude at the same rigidity; (2) the proton modulation is less than the electron modulation at the same value of $P\beta$ and considerably less at the same energy; (3) the modulation of electrons can be represented by a form $\ln (dj_2/dj_1) \simeq 1/P$ or $1/P\beta$ between 0.5 and 3 BV; (4) this fractional decrease is consistent with the neutron monitor decrease that represents particles of a mean rigidity ≃10 BV. From these comparisons we estimate that energy loss processes cannot contribute greater than 20% of the observed changes in differential intensity in the rigidity range from 0.5 to 1 BV. The modulation of both electrons and protons suggests a picture in which the rigidity dependence of the diffusion coefficient, and consequently of the modulation, is continuously changing with rigidity, this varying rigidity dependence presumably directly mirroring the spectrum of the irregularities in the interplanetary magnetic field that are scattering the particles. (auth)

5161 CHERENKOV-SCINTILLATION COUNTER MEASUREMENTS OF NUCLEI HEAVIER THAN HELIUM IN THE PRIMARY COSMIC RADIATION. 1. CHARGE COMPOSITION AND ENERGY SPECTRA BETWEEN 200 MeV/NUCLEON AND 5 bev/NUCLEON. Webber, W. R.; Ormes, J. F. (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 72: 5957-76(Dec. 1, 1967).

Studies of the energy spectrum and charge composition of the primary cosmic radiation were carried out on seven balloon flights at five geomagnetic latitudes using a Cherenkov-scintillation counter telescope that has geometrical factor ≃50 st cm². The calibration of the instrument for particles of various energy and charge is discussed. Particular attention is paid to the problem of "background" as it affects the energy spectrum and charge resolution and to the effects of nonlinearities in light output in the scintillators for highly charged particles. The data are corrected to the top of the atmosphere using direct measurements of the atmospheric absorption of the various charge components. Differential spectra for particles with nuclear charges from $3 \leq Z \leq 26$, covering the energy range 200 MeV/nucleon to 5 BeV/nucleon are presented, based on the identification of some 6000 nuclei with charge greater than helium. These spectra are adjusted to the mean Mt. Washington bihourly neutron rate of 2440 that prevailed during this series of flights in 1964 and 1965. This rate is within 2% of the highest rate achieved by this monitor during the sunspot minimums in 1954 and 1965. Findings summarized are: (1) Between 2.5 and 12 BV rigidity, the differential rigidity spectra of helium and all heavier nuclei may be represented by power laws with negative exponent = −2.2 ± 0.05. There is some evidence that light nuclei and very heavy nuclei have slightly steeper spectra. At higher rigidities it appears that the spectral exponent for all charges must continue to increase reaching a value of −2.5 or −2.6 appropriate to rigidities >100 BV. (2) The abundance of odd nuclei of charges 9 to 7 is so small at 4 g/cm² atmospheric depth that a major fraction of them would be expected to be secondaries created in the atmosphere. This observation suggests a very low fragmentation probability for even nuclei into odd nuclei in this charge range, both in the atmosphere and in interstellar space. The L/M ratio as a function energy/nucleon is also presented. (auth)

5162 THE 11-YEAR SOLAR MODULATION OF COSMIC RAYS AS DEDUCED FROM NEUTRON MONITOR VARIATIONS AND DIRECT MEASUREMENTS AT LOW ENERGIES. Lockwood, J. A. (Univ. of New Hampshire, Durham); Webber, W. R. Contract AF19(628)-2352. J. Geophys. Res., 72: 5977-89(Dec. 1, 1967).

The variation in the cosmic-ray intensity recorded by neutron monitors from 1958 to 1965 was investigated to deduce the form of the solar modulation of the cosmic radiation. The neutron monitor data were carefully selected and examined. The observed quarter-year average changes in the intensity at the neutron-monitor stations were then compared with the calculated changes using different modulation functions. Finally, the observed variations in the intensities recorded by neutron monitors were compared with the variations of the radiation observed at the top of the atmosphere and in space. The change in both the neutron monitor intensity and the primary cosmic radiation can be described by a modulation of the form $\exp(-K/P)$ in the rigidity range $0.5 < P < 50$ GV. (auth)

5163 EFFECTS OF THE NATURE OF MATTER TRAVERSED BY COSMIC RAYS ON ITS COMPOSITION AND ENERGY SPECTRUM. Apparao, M. V. K.; Ramadurai, S. (Tata Inst. of Fundamental Research, Bombay). J. Geophys. Res., 72: 5991-5 (Dec. 1, 1967).

The effects due to the presence of helium and the state of ionization of the matter traversed by cosmic rays have been studied. The amount of matter traversed by cosmic rays expressed in g/cm², as deduced by the usual assumption that the matter traversed is all neutral hydrogen, can lead to an erroneous value. The presence of helium increases this value, a considerable portion of it being due to helium. The ionized (partial) nature of the matter increases the ionization loss of cosmic-ray nuclei. The effect of this on energy spectra has been demonstrated. (auth)

5164 COSMIC-RAY MUONS AND THE ATMOSPHERIC COEFFICIENTS NEAR GEOMAGNETIC EQUATOR. Wang, C. P. (Case Western Reserve Univ., Cleveland); Lee, A. H. J. Geophys. Res., 72: 6107-12(Dec. 1, 1967).

Cosmic-ray muon intensity and atmospheric coefficients obtained with two cubical counter telescopes, operated near sea level at Hong Kong, are reported. (J.H.M.)

5165 COSMIC BACKGROUND MEASUREMENT AT A WAVELENGTH OF 9.24 mm. Ewing, M S.; Burke, B. F.; Staelin, D. H. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 19: 1251-3(Nov. 20, 1967).

The cosmic background temperature measured at 9.24 mm is 3.16 ± 0.26°K, which is consistent with measurements at longer wavelengths. (auth)

5166 ON THE K/π RATIO FROM MUONIC INTENSITY AT 90 mwe AND AT LARGE ZENITH ANGLES. Briatore, L.; Dardo, M. (CNR, Turin, Univ., Turin). Nuovo Cim. (10), 51B: 475-82(Oct. 11, 1967).

Cosmic-ray muonic intensity was measured underground at 90 mwe and at large zenith angles. The comparison of the experimental data with the directional intensity calculated on the basis of the isobaric-model energy spectra allows to derive the K/π ratio at production. $K/\pi \simeq 0.18$ in the primary energy interval $\sim 4.10^2$ to $\sim 10^4$ GeV, in agreement with works of other authors carried out with many different experimental techniques. (auth)

5167 ORIGIN OF LOW-ENERGY COSMIC RAYS FROM OUTSIDE THE SOLAR SYSTEM. Burbidge, G. R.; Fowler, W. A.; Hoyle, F. (Cambridge Univ., Eng.). Nature (London), 216: 22-5(Oct. 7, 1967).

The abundances of heavy nuclei in the low-energy primary cosmic-ray flux can be accounted for by the coexistence of two components, one of which has undergone nuclear spallation reactions. The passage of primary cosmic rays through the ambient gas clouds thought to be associated with quasi-stellar objects is one way in which spallation on a sufficient scale may have occurred. (auth)

5168 COSMIC RAYS IN THE INTERPLANETARY MEDIUM. Gleeson, L. J.; Axford, W. I. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 149: L115-8(Sept. 1967).

The equations governing the behavior of cosmic particles in a model of the interplanetary medium are discussed. The equations

provide direct information concerning the streaming and spatial gradient of cosmic rays and when combined reduce to the Fokker–Planck equation used in this context by Parker (1965, 1966). It is shown that in suitable conditions the cosmic rays behave as if they were being modulated by a heliocentric electric field, although this can only be an approximate description of the overall modulation. (W.D.M.)

5169 LOW-ENERGY COSMIC RAYS AND THE ELECTRON DENSITY IN H I REGIONS. Habing, H. J.; Pottasch, S. R. (Kapteyn Astronomical Lab., Groningen, Netherlands). Astrophys. J., 149: L119-20(Sept. 1967).

The intensity of cosmic rays as a function of kinetic energy shows a steep increase from high energies (10^{10} GeV/n) down to low energies (0.5 GeV/n). The spectrum at still lower energies is more uncertain because of the degree of solar modulation. Recently, Gloeckler and Jokipii(1967) suggested that the spectrum remains steep down to at least 15 MeV/n. As a consequence the intensity of the rays becomes quite high at such low energies. From their data a proton intensity at 20 MeV of 2.5 protons cm^{-2} sec^{-1} MeV^{-1} is read. It is stressed that in obtaining this result the authors applied a correction of the order of 10^3 to the observed intensities at 20 MeV in order to account for modulation effects in the interplanetary medium. (W.D.M.)

5170 HANDBUCH DER PHYSIK. BAND XLVI/2. KOSMISCHE STRAHLUNG II. (Encyclopedia of Physics. Volume XLVI/2. Cosmic Rays II). Fluegge, S.; Sitte, K. (eds.). Berlin, Heidelberg, New York, Springer-Verlag, 1967. 661p. DM 178.–; $44.50. (In English and German).

Eight papers are included on theory of cascade showers, cosmic rays and high-energy physics, spectrum and charge composition of primary cosmic radiation, high-energy photons and neutrinos from cosmic sources, time variations of intensity, nucleons in the atmosphere, cosmic-ray produced radioactivity on the Earth, and effects on meteorites. Separate abstracts were prepared on each paper. (W.D.M.)

For abstracts of individual sections see: 5171–5178.

5171 THEORY OF CASCADE SHOWERS. Nishimura, J. pp 1-114 of Handbuch der Physik. Band XLVI/2. Fluegge, S.; Sitte, K. (eds.). Berlin, Heidelberg, New York, Springer-Verlag, 1967.

The solutions of the several shower theories are reviewed under a unified mathematical treatment, i.e., functional transformations and integral representations of the finite series, and special attention is paid to clear exposition of the physical basis and the limitation of each theory. The elementary processes, the basic phenomena for the electron shower, are summarized, and the general behavior of the shower functions expected from these processes are discussed. Starting from the Landau–Rumer solution, the results of Snyder and Scott are derived, and three-dimensional shower theories, with and without consideration of the effect of large angle scattering, are developed along the line of Kamata and Nishimura, as a general extension of the theories of Snyder and Scott. Limitation of the applicability of those shower functions are critically examined, and the applications of the shower theory to the analysis of cosmic-ray phenomena are described. (W.D.M.)

5172 COSMIC RAYS AND HIGH-ENERGY PHYSICS. Fujimoto, Y.; Hayakawa, S. pp 115-80 of Handbuch der Physik. Band XLVI/2. Fluegge, S.; Sitte, K. (eds.). Berlin, Heidelberg, New York, Springer-Verlag, 1967.

Cosmic rays and high-energy physics are discussed in terms of the discovery of multiple production, direct observations of high-energy interactions, behavior of high-energy cosmic-rays, and models of multiple production. Cosmic-ray data are summarized. (W.D.M.)

5173 SPECTRUM AND CHARGE COMPOSITION OF THE PRIMARY COSMIC RADIATION. Webber, W. R. pp 181-264 of Handbuch der Physik. Band XLVI/2. Fluegge, S.; Sitte, K. (eds.). Berlin, Heidelberg, New York, Springer-Verlag, 1967.

An attempt is made to present the current status (as of mid-1964) and some of the outstanding problems relating to the study of the primary cosmic radiation. Main interest is centered on the following features of the data relating to the primary radiation: (1) the charge and isotopic composition; and (2) the energy or rigidity spectra of the various components. These data are presented in detail, together with an examination of their significance in relation to theories of the origin and propagation of this radiation to the Earth. (W.D.M.)

5174 HIGH ENERGY PHOTONS AND NEUTRINOS FROM COSMIC SOURCES. Gould, R. J.; Burbidge, G. R. pp 265-309 of Handbuch der Physik. Band XLVI/2. Fluegge, S.; Sitte, K. (eds.). Berlin, Heidelberg, New York, Springer-Verlag, 1967.

Most of the photon-producing processes are treated where the effects of the high-energy electrons produced in cosmic-ray nuclear collisions are considered. The problem of discrete sources of x rays and the possibility of observing extragalactic sources of high-energy photons are discussed. High-energy neutrino astronomy is intimately related to high-energy photon astronomy, since in the production of a shower of pions from a nuclear collision, neutrinos result from the charged pion and muon decays and photons result directly from neutral pion decays. Neutrino sources are discussed. (W.D.M.)

5175 TIME VARIATIONS OF THE COSMIC RAY INTENSITY. Quenby, J. J. pp 310-71 of Handbuch der Physik. Band XLVI/2. Fluegge, S.; Sitte, K. (eds.). Berlin, Heidelberg, New York, Springer-Verlag, 1967.

Experimental data which are most useful in giving information about the interplanetary fields are selected, and this evidence is then compared with various theoretical models. Variations of atmospheric origin are not discussed. Intensity variations which can arise from the interaction of interplanetary plasma and the geomagnetic field are considered. (W.D.M.)

5176 NUCLEONS IN THE ATMOSPHERE. Schopper, E.; Lohrmann, E.; Mauck, G. pp 372-550 of Handbuch der Physik. Band XLVI/2. Fluegge, S.; Sitte, K. (eds.). Berlin, Heidelberg, New York, Springer-Verlag, 1967. (In German).

Topics discussed include the primary component of cosmic radiation, nuclear interactions of the nucleon component in the atmosphere, protons in the atmosphere, and neutrons in the atmosphere. (W.D.M.)

5177 COSMIC RAY PRODUCED RADIOACTIVITY ON THE EARTH. Lal, D.; Peters, B. pp 551-612 of Handbuch der Physik. Band XLVI/2. Fluegge, S.; Sitte, K. (eds.). Berlin, Heidelberg, New York, Springer-Verlag, 1967.

This review is concerned mainly with the direct production of isotopes on Earth and within their inventory in different parts of the geosphere. Since the inventories are sensitive to the time scale and nature of geophysical and geochemical processes, a brief discussion of some of these processes is included. Some important references on experimental techniques used in geophysical tracer work are listed. (W.D.M.)

5178 EFFECTS OF COSMIC RAYS ON METEORITES. Honda, M.; Arnold, J. R. pp 613-32 of Handbuch der Physik. Band XLVI/2. Fluegge, S.; Sitte, K. (eds.). Berlin, Heidelberg, New York, Springer-Verlag, 1967.

Topics discussed include course of radiation in a meteorite, history of meteorites, secular equilibrium, time variations, meteorite samples, measurements, cosmic-ray exposure ages, production rates, and recovered artificial satellites. (W.D.M.)

Direct Energy Conversion

Refer also to abstract 5332.

5179 (CEA-tr-R-1901) PARAMETRES DES CONVERTISSEURS MHD COMPTE TENU DE L'INSTABILITE DU PLASMA IONISE. (Parameters of MHD Converters Taking into Account Instability of the Ionized Plasma). Gurashvili, V. A.; Kareev, Yu. A.; Nedospasov, A. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated into French from report IAE-1348. 25p. (In French). Dep. CFSTI. JCL $2.60 fs, $0.95 mf.

The calculations on MHD converters with a conductivity near equilibrium, taking into account the ionization instability, are reported. Argon and mercury vapor seeded by cesium vapor were studied as plasma components. (tr-auth)

5180 (CEA-tr-R-1903) ETUDE D'UNE DECHARGE ELECTRIQUE ENTRETENUE PAR LA FORCE DE LORENTZ. (Study of Electric Discharge Maintained by Lorentz Force). Vitshas, A. F.; Golubev, V. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated into French from report IAE-1328. 25p. (In French). Dep. CFSTI. JCL $2.60 fs, $0.95 mf.

Experimental results are reported for an Ar jet doped with Cs and propagated perpendicularly to a magnetic field in a shock tube, at the entry of which the Cs is ionized with an electric discharge. It is shown that there exists an angular electric discharge in the volume of the shock tube maintained by the azimuthal Lorentz force $\vec{V} \times \vec{B}$. (tr-auth)

5181 (CEA-tr-R-1904) QUELQUES RESULTATS DE RECHERCHES A L'AIDE DE L'INSTALLATION EXPERIMENTALE DE PUISSANCE AVEC UNE TUYERE MHD. (Some Results of

Studies of an Experimental Power Installation with an MHD Duct). Kirillin, V. A.; Sheindlin, A. E. Translated into French from Russian Report. 27p. (In French). Dep. CFSTI, JCL $2.60 fs, $1.04 mf.

An experimental installation powered with an MHD converter operating in open cycle with the combustion products of natural gas seeded by K_2CO_3 was constructed. The installation, combustion chamber, MHD converter, and electrodes and insulators for the converter are described. The effects of modifying various parts of the installation on the output were determined. The technique used for reheating of the air by high-temperature regeneration is described. The techniques used for the introduction and elimination of ionizable seeds are given. (J.S.R.)

5182 EXPERIMENTAL INVESTIGATION OF ELECTRODE OPERATION IN AN AIR STREAM CONTAINING POTASSIUM ADMIXTURE. German, V. O.; Lyubimov, G. A.; Parfenov, B. V. (Moscow State Univ.). Teplofiz. Vys. Temp., 5: 472-9 (May-June 1967). (In Russian).

The operation of an electrode in an air plasma flow, with approximately 1% potassium admixture at a gas temperature of about 2500°K in the working section and pressure of 1 atm, was studied. Data are presented on the regularity of cathode potential drop and the dependence of this drop on current density and electrode temperature. These data were obtained through the treatment of electrode-probe and electrode volt–ampere characteristics. Quantitative reduction of these data indicates they are in satisfactory agreement with the near-electrode theory previously presented by one of the authors (Lyubimov, Zh. Prikl. Mekh. Tekh. Fiz., No. 5, (1963); No. 5, (1964); No. 4, (1965)). (ATD)

5183 CALCULATION OF CORE TEETH GEOMETRY OF A 3-PHASE INDUCTION MHD MACHINE. Bushman, A. K.; Kalnin', T. K.; Lielpeter, Ya. Ya. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 4, 105-10(1967). (In Russian).

A method for calculating the optimum geometric dimensions of the core teeth area for a rectangular form of the tooth and the slot, without considering the saturation of the ferromagnetic material, is presented. The proposed geometry of the area ensures the maximum linear current in the stator at the given values of magnetic induction in the teeth, current density in the windings, and the filling factor of the slot. The optimum relation between the widths of the tooth and the slot is found to be near unity both at a saturated and an unsaturated magnetic circuit. (auth)

5184 MHD CYCLES AND LARGE SCALE EXPERIMENTS. I. THE SCIENCE OF MHD GENERATORS: A CRITICAL SURVEY. Wright, J. K. (Berkeley Nuclear Labs., Eng.). Phil. Trans. Roy. Soc. London, Ser. A, 261: 347-59(July 6, 1967).

Various types of MHD generator are discussed and the basic theory of MHD generation is described. The open cycle fossil fuel type of MHD generator system in which the exhaust gases from the MHD duct are used to power a steam turbo-alternator-generator is discussed in detail and the major problem areas identified. These include the stability of the flow in the MHD duct, provision of long-lived electrodes, air preheaters, seed recovery apparatus, and development of a suitable superconducting magnet. Influence of the parameters of the various components on the performance of the complete MHD/steam turbine plant is discussed. A description is given of a 200-Mw thermal input light oil/oxygen MHD generator. The objects of this rig are to demonstrate that large fractions (~10%) of the enthalpy of the combustion products may be extracted as electricity, to obtain information about heat transfer at the high Reynolds numbers and to gain experience in building and operating a large MHD device and thus bring out any unforeseen practical details. Also constructed were a coal combustion chamber, to demonstrate that coal may be burnt at a sufficient intensity to be of interest to MHD, and a rig capable of burning a coal/oil slurry or residual fuel oil, with the dual objective of providing information on the duct and seed recovery problems associated with the use of coal in an MHD components, particularly ducts and electrodes. If this research program is successful, the 200-Mw rig will be converted into a pilot plant incorporating the major features of air heaters and seed recovery apparatus. (BBB)

5185 MHD CYCLES AND LARGE SCALE EXPERIMENTS. II. RECENT PROGRESS IN THE DEVELOPMENT OF COMBUSTION FIRED MHD GENERATORS. Brogan, T. R. (Avco Everett Research Lab., Everett, Mass.). Phil. Trans. Roy. Soc. London, Ser. A, 261: 360-7(July 6, 1967).

Advances in the development of the large combustion fired MHD generator are reviewed, with emphasis on commercial central station application. The main objective of the development of the combustion fired MHD generator has been to overcome certain disadvantages with combustion gases in particular, such as chemical reactivity, low electrical conductivity necessitating high magnetic field, and the problems associated with seeding and corrosion in commercial systems. The segmented electrode Faraday configuration MHD generator is highly efficient but has the disadvantage of delivering its output in a multiplicity of loads each of which floats at a different potential. Thus recent work, which is described, in MHD generator fluid mechanics and long duration channel development has been concentrated on examination of the high-voltage 2-terminal Hall configuration. The chemistry and economics of seeding must be carefully evaluated in order to assess the potential of MHD. The feasibility of efficient low cost seed recovery employing vapor phase separation was demonstrated. Superconducting field coils appear to be essential for commercial MHD power generation, the "stabilized" principle of constructing such coils is described. By use of this principle it is possible to operate a large coil on the H–I curve of a short sample of wire. This development reduces the construction of large superconducting coils to an engineering problem. (BBB)

5186 MHD CYCLES AND LARGE-SCALE EXPERIMENTS. III. THE PROSPECTS FOR CLOSED-CYCLE MPD POWER GENERATION. Lindley, B. C. (C. A. Parsons and Co. Ltd., Newcastle-upon-Tyne, Eng.); McNab, I. R.; Dunn, P. D. Phil. Trans. Roy. Soc. London, Ser. A, 261: 368-93(July 6, 1967).

Basic features of closed-cycle MPD systems are described, on the basis of the 3 main combination cycles (direct nuclear, indirect nuclear, indirect fired) which could be adopted for commercial power stations. Because of the high temperatures and attendant problems associated with thermal ionization of the working gas plasma, emphasis is placed upon achieving nonequilibrium ionization. This phenomenon is generally applicable only in closed cycle systems employing certain gases as the working fluid: the basic theory and required operating parameters of several techniques for inducing nonequilibrium ionization are reviewed. Matching a heat source, whether based on combustion or nuclear energy, to the MPD stage imposes a number of restrictions. Nuclear reactors to provide temperatures suitable for MPD systems (perhaps up to 1800°C) have yet to be developed, but design criteria can be formulated. Cycle studies to specify operating parameters (including temperature, pressure, and associated steam cycle) are presented. The technical feasibility of an indirect fired heat exchanger is considered, and over-all system performance, development time scale, and incentives are examined. Experimental research and development towards closed cycle MPD power generation in progress at International Research and Development Co. Ltd and at the Atomic Energy Research Establishment, Harwell, are described. Details of the program and achievements in terms of experimental data are presented. Prospects for closed cycle MPD power generation are reviewed. (BBB)

5187 MHD CYCLES AND LARGE-SCALE EXPERIMENTS. IV. THE PROSPECTIVE ECONOMICS AND THERMAL EFFICIENCY OF LARGE-SCALE OPEN-CYCLE MHD STATIONS. Kirillin, V. A.; Rossievskii, G. I.; Styrikovitch, M. A.; Scheindlin, A. E. (High Temperature Inst., Moscow). Phil. Trans. Roy. Soc. London, Ser. A, 261: 394-400(July 6, 1967).

To assess the economic attractiveness of prospective MHD power stations, their thermal efficiency and construction costs are considered, as well as a thermal analysis on the basis of some fossil-fuel power stations, with 2 key temperatures, the inlet and outlet stagnation temperatures of the MHD generator itself, being changed from one calculation to the next. The calculated efficiencies were compared which, together with other factors, suggested optimum plant size and characteristics. The normal cycle was considered in which the gases leaving the MHD generator are used to preheat the air for combustion and the remaining heat is used for raising steam for a conventional turbo-alternator. Factors influencing the ratio of the power from the MHD generator and from the alternator were taken into account. Air preheat temperatures of between 1300 and 1700°C were considered, at which overall efficiencies of 51 and 61% could be attained. If the generator length was restricted to between 10 and 15 m to limit duct heat losses, magnetic fields of 4 to 6 Wb/m^2 were required. The use of oxygen enrichment was found at present to be uneconomic, but reacting methane with steam (an endothermic reaction) to form the fuel to be burnt is an attractive alternative process although not as good thermodynamically as air preheating. Economic considerations indicate that MHD may only be useful for high cost fuels. (BBB)

5188 MHD CYCLES AND LARGE-SCALE EXPERIMENTS. V. FIRST RESULTS OF THE ELECTRICITE DE FRANCE 8-MW MHD EXPERIMENTAL RIG AT CENTRE DE RECHERCHES ET D'ESSAIS DES RENARDIERES. Pericart, J.; de Montardy, A.

(Electricite de France, Renardieres). Phil. Trans. Roy. Soc. London, Ser. A, 261: 406-18 (July 6, 1967).

Characteristics and scope of the Renardieres MHD generator experimental rig are described. The rig is used mainly for tests on open cycle MHD generation on a scale intermediate between the lab and operational power plant; it is designed for semipermanent operation (8 consecutive hr). The 8000-Kw thermal power is obtained by combustion of light oil in oxygen-enriched air (1 volume of nitrogen for 2 volumes of oxygen). A solution of potassium hydroxide in methyl alcohol is used to introduce the ionizing seed. The test section is 1.30 m long and has a constant internal cross section of 7 × 13 cm. Input velocity of the gases is 600 m/sec, with a static temperature of about 2900°K and a static pressure of 1.9 bar (abs). The steady state magnetic field, in normal operating conditions, is 2.6 to 2.8 T (maximum 3.1 T). The electromagnet and test section are cooled by de-ionized water circulating in closed loops. Test section cooling circuits are equipped with meters for measuring and recording the flow rate and temperature of the water at the input and output of the elements so that accurate heat transfer measurements are possible. (BBB)

5189 MHD CYCLES AND LARGE-SCALE EXPERIMENTS. VI. DISCUSSION. Thring, M. W. (London Univ.); Fells, I.; Szendy, C.; Nowacki, P. J.; Hoy, H. R.; Jeffrey, R. C.; Pole, R. C.; Brogan, T. R.; Wright, J. K. Phil. Trans. Roy. Soc. London, Ser. A, 261: 419-28 (July 6, 1967).

To obtain a gas velocity corresponding to a Mach number greater than one in a d-c type MHD generator requires an adiabatic temperature drop in the nozzle of many hundreds of degrees Kelvin. A diagram is presented of the work going on in all parts of the world in the attempt to solve the basic problem of obtaining a high gas conductivity and a high gas velocity simultaneously. Three main types of systems are described. Design and layout difficulties that would have to be overcome to provide a suitable heat exchanger are discussed, and the conditions under which exchangers of the regenerative type would be operating are outlined. Some problems of using coal to produce high-temperature gases for MHD power-generating systems, being investigated at the British Coal Utilization Research Association, are also discussed. In present designs of commercial, open-cycle MHD generators based on the combustion of pulverized coal or heavy residual fuel oil, to achieve the high temperature required (~3000°K), the combustion air must be preheated to about 1450°C. The alternative of oxygen enrichment would be too expensive. In systems using oil, this high air preheat may lead to extensive cracking of the oil before combustion. Another factor which may affect the combustion process is the seed which has to be introduced into the gases to make them sufficiently electrically conducting before they enter the MHD generator itself. A combustion chamber being built to investigate some of these problems is described. (BBB)

5190 MHD PLANT, COMBUSTION TECHNIQUES, AND SEEDING. VII. TEMPERATURE AND VELOCITY MODULATED MHD SYSTEMS. Ibberson, V. J. (London Univ.); Harris, D. Phil. Trans. Roy. Soc. London, Ser. A, 261: 429-39 (July 6, 1967).

Ways plasmas used for generating MHD power may be modulated in order to provide higher power densities were studied. Temperature and/or velocity modulation may be obtained in a quasi-steady-flow combustion system, e.g., by introducing striations of high temperature fluid, or in a nonsteady system by exciting pulsations or oscillations. Studies on striations are outlined and relevant work on nonsteady modulation is discussed. A description is given of the joint work on an oscillatory vortex MHD generator (Univ. of Sheffield) and a proposed linear MHD system (Queen Mary Coll., London). The 2-dimensional rocket motor designed at Sheffield was used to determine the extent to which the amplitude of oscillation modulates temperature, hence electrical conductivity of the gas; the range of amplitudes and frequencies obtainable for different fuel/air ratios and combustion chamber lengths; and the possibility of obtaining a trapped detonation wave system with its correspondingly high power density. In the linear generator, a small rocket-type combustion chamber was used to obtain a traveling longitudinal combustion oscillation. It was concluded that the prospect for MHD power generation using combustion oscillations to modulate the velocity and temperature of the plasma appears is good. Substantially higher local power densities were shown to be theoretically possible. The effect of MHD braking has yet to be considered. The traveling wave system is most suitable for modulation and 2 possible modes of oscillation, namely longitudinal and tangential, give rise to generators of different characteristics, each of interest for different applications. With the linear generator all the through flow of gas reacts with the magnetic field but the pressure amplitude is somewhat restricted by the steepening process which leads to shock waves. The vortex generator is less liable to this restriction but there is a radial component of flow which is lost as regards MHD power extraction. This loss, however, can be minimized as tangential velocity and the mass flow radial component can be varied independently. This type of generator should be suitable for light-weight generators for mobile power stations and space vehicles. (BBB)

5191 MHD PLANT, COMBUSTION TECHNIQUES, AND SEEDING. VIII. LEAKAGE CURRENTS IN A SEGMENTED-ELECTRODE GENERATOR. Haines, M. G. (Imperial Coll. of Science and Tech., London). Phil. Trans. Roy. Soc. London, Ser. A, 261: 440-54 (July 6, 1967).

Plasmas commonly used in magnetohydrodynamic power generation experiments possess a high Hall coefficient, β, because large magnetic fields are employed to obtain maximum interaction per unit volume and because, being only slightly ionized, the dominant electron–atom collision cross section which determines the resistivity is small. Under these conditions β is independent of electron density. The Hall effect can be included implicitly in a tensor conductivity or written explicitly in an Ohm law containing a scalar conductivity. The latter method is considered here. Segmented electrodes are used extensively in magnetohydrodynamic flow experiments to overcome the high-impedance present in a continuous electrode system when the plasma has a high β. Until recently the theoretical study of a segmented system has artificially constrained the current to flow directly across the duct. Since this present work was undertaken, Witalis has investigated the onset of shorting of the Hall voltage between adjacent segments by leakage currents due to insufficiently long insulator sections, by assuming that the segmentation length is much smaller than the duct width. Three methods are adopted for analyzing the effect of leakage currents and obtaining the electrical characteristics. These are conformal mapping, Fourier series, and an approximate equivalent circuit. Only the Fourier analysis method requires no further assumptions other than periodicity and it reproduces Witalis's criterion for shorting when his additional assumptions apply. The equivalent circuit method is easier to apply and will be more useful for a practical nonuniform duct. (BBB)

5192 MHD PLANT, COMBUSTION TECHNIQUES, AND SEEDING. IX. FLOW OF CURRENT IN A CROSS-CONNECTED MHD GENERATOR WITH FOUR ELECTRODES. Nemkova, N. G.; Alavidze, G. R. (High Temperature Inst., Moscow). Phil. Trans. Roy. Soc. London, Ser. A, 261: 455-60 (July 6, 1967).

Current flow patterns in an MHD generator with 4 electrodes, 2 on each side of the duct, are derived. The upstream electrode on the cathode side is connected to the downstream one on the anode side and a load across the other pair of electrodes produces a rudimentary cross-connected generator. The fluid properties, flow conditions, and magnetic field were assumed to be uniform across the duct and a 2-dimensional analysis was made. A Schwarz–Christoffel transformation was employed to find potential and current distributions. Three simultaneous linear equations must be solved to give explicit equations for currents and potentials. Which portion of the electrode is subjected to useful load current and which portion is allowing leakage current to flow could be determined. These calculations should therefore indicate the distance at which the electrodes should be set apart so that the leakage current is reduced to a suitable minimum, or to determine the conditions under which the leakage current vanishes. The method is extendable to the case of more electrodes. (BBB)

5193 MHD PLANT, COMBUSTION TECHNIQUES, AND SEEDING. X. WAVE GROWTH IN MHD GENERATORS. Heywood, J. B. (Central Electricity Research Labs., Leatherhead, Eng.); Wright J. K. Phil. Trans. Roy. Soc. London, Ser. A, 261: 461-70 (July 6, 1967).

It was shown that, in an MHD generator, acoustic waves can grow due to the coupling of fluctuations in electrical conductivity, Hall parameter, and thermodynamic properties of the gas, with the ohmic dissipation and electromagnetic body forces. A new analysis of this phenomenon is presented in which waves traveling at an arbitrary angle to the flow direction in a plane perpendicular to the magnetic field are considered. In contrast to McCune's treatment the thermodynamic properties are not restricted to perfect gas laws; and the condition for spatially and temporally growing waves is examined using a general dispersion relation which includes both these types of wave. Detailed consideration is given to (1) stationary waves in supersonic flow, and (2) traveling waves in the subsonic flow found in the Central Electricity Generating Board 200-MW thermal input generator being built at Marchwood, and a possible power station MHD generator. It was found that the waves in the 200-MW rig which burns kerosene in oxygen will be damped. But in an oil–air combustion products generator for Hall parameters of order 3 or greater, it was found

that stationary waves which grow rapidly may occur at Mach numbers greater than about 1.7; and in subsonic flow waves propagating antiparallel to the steady current vector may be amplified, though the growth rate is not excessive. In noble gas MHD generators these waves are more unstable than in the oil, air combustion products generator. (BBB)

5194 MHD PLANT, COMBUSTION TECHNIQUES, AND SEEDING. XI. EQUILIBRIUM AND NONEQUILIBRIUM ELECTRICAL CONDUCTIVITY OF SEEDED COMBUSTION PRODUCTS. **Freck, D. V. (Central Electricity Research Labs., Leatherhead, Eng.). Phil. Trans. Roy. Soc. London, Ser. A, 261: 471-85 (July 6, 1967).**

It was shown, on the basis of measurements by 4-electrode and microwave techniques and from theoretical calculations, that equilibrium electrical conductivity varies with fuel/air ratio, being higher in fuel-rich conditions, and that the Cl and S impurities in power station fuels will not signifficantly affect the conductivity under MHD generator conditions. Experiments on nonequilibrium conductivity in seeded combustion products at 1500°K are described. The form of the current–field curve at high values of the ratio of electrical field to molecule density was investigated. At a certain value of the field, the current was found to increase many times above the equilibrium value, with little increase in field. To interpret these results, a theory is presented in which ionization by electrons having energies greater than the ionization potential is balanced by a 3-body recombination process involving electrons, positive potassium ions, and neutral molecules. This gives a current-field curve of the same shape as that experimentally observed but the experimental value of the field at which the current rises differs from the theoretical value by about 25%. The use of this nonequilibrium conductivity in generators is discussed. (BBB)

5195 MHD PLANT, COMBUSTION TECHNIQUES, AND SEEDING. XII. COMPOSITION AND THERMODYNAMIC PROPERTIES OF COMBUSTION PRODUCTS OF METHANE CONTAINING POTASSIUM CARBONATE. **Yungman, V. S.; Gurvich, L. V.; Rtishcheva, N. P. (High Temperature Inst., Moscow). Phil. Trans. Roy. Soc. London, Ser. A, 261: 486-9 (July 6, 1967).**

The composition of combustion products of methane and oxygen-enriched air between 1000 and 4000°K and the effect of introducing K_2CO_3 into the mixture were determined. This caused electrons to appear in large quantities and redistributions in the proportions of some compounds and, at different temperatures, to the formation of a variety of K compounds. The formation of those compounds had a considerable effect on the concentration of electrons. The chemical composition of the gases was markedly influenced by the addition of K_2CO_3. Below 2000°K the O_2 content was reduced and the CO content concentration occurred at about 2000°K. All these features were caused by the formation of K compounds and mostly by the formation of KOH which largely dissociates above 2000°K, where the effects on chemical composition of adding K_2CO_3 became less pronounced though still noticeable. (BBB)

5196 MHD PLANT, COMBUSTION TECHNIQUES, AND SEEDING. XIII. AN EXPERIMENTAL STUDY OF GAS-BORNE SUSPENSIONS OF THERMIONIC EMITTERS AS MHD WORKING FLUIDS. **Waldie, B.; Fells, I. (Univ. of Newcastle-upon-Tyne, Eng.). Phil. Trans. Roy. Soc. London, Ser. A, 261: 490-5 (July 6, 1967).**

The use of gaseous suspensions of thermionically emitting particles as alternatives to alkali-metal-seeded gases for use as MHD working fluids is discussed. Theoretical relations are used to show that suspensions of BaO in Ar can have significantly higher electrical conductivities than thermally ionized Ce–Ar mixtures at temperatures below about 2000°K. This advantage is emphasized at pressures above atmospheric pressure. Experimental studies to check the theoretically predicted conductivities are described. A technique was developed for the preparation of submicron suspensions of BaO and other alkali earth oxides in inert gases. A suspension of BaO particles in Ar was shown to have a conductivity of 0.1 mho/m at atm pressure and 1600°K. This value is low, because of the relatively large average particle size (0.3 μm dia), but is of the same order as the theoretical conductivity for the experimental conditions. (BBB)

5197 MHD PLANT, COMBUSTION TECHNIQUES, AND SEEDING. XIV. THE BEHAVIOR OF VARIOUS ELECTRODES AND INSULATORS IN AN EXPERIMENTAL MHD GENERATOR. **Devime, R.; Lecroart, H.; Porte, R.; Yerouchalmi, D. (CEA-CEN, Saclay, France). Phil. Trans. Roy. Soc. London, Ser. A, 261: 496-503 (July 6, 1967).**

Some features of an MHD generator in which there is an electrically produced temperature modulation of the gas stream are discussed. Methods and equipment for producing a striated plasma are described together with the first experimental apparatus (MHD 5) used to study such flows. A critical examination of the materials employed in the first series of experiments led to the conclusion that hot electrodes were most suitable and indicated other aspects which would need further study. The limitations of the MHD 5 duct which led to the design of MHD 6 and the gas conditions, geometric dimensions, duct rigidity, thermal expansion problems, material compatibility and heat transfer of this equipment are discussed. It is expected that some of the problems encountered in the MHD 5 generator, which highlighted the importance of materials in generator construction, have been overcome in the design of duct MHD 6. For MHD 6, with a front face temperature of 1900°K, a back water-cooled face of 350°K and a heat flux of 7 W/cm^2, the zirconia electrodes used are 25 mm thick and the insulating walls of strontium zirconate (with 20% porosity) are 20 mm thick. Both electrode and insulator ceramics are clamped on copper water boxes as separate units for mounting together to form the duct. One major problem remains: to find or devise ceramic conductors whose conduction mechanism is electronic rather than ionic so that electrolytic effects will be eliminated. (BBB)

5198 MHD PLANT, COMBUSTION TECHNIQUES, AND SEEDING. XV. NEW CERAMICS BASED ON MONOCLINIC ZIRCONIA. **Anthony, A. M. (CNRS, Bellevue, France); Yerouchalmi, D. Phil. Trans. Roy. Soc. London, Ser. A, 261: 504-13 (July 6, 1967).**

For use in an MHD channel a material must have not only a high melting point and chemical inertness but must also resist thermal shocks and abrasion; furthermore, the electrical conductivity at 2000°K should be, for the insulating walls, at most, $^1/_{10}$ that of the channel plasma (10 mho/m), while the electrodes should have at least a 10 times greater conductivity than the plasma with an electronic rather than ionic conduction mechanism. In addition, the electrodes should have a thermionic emission at least equal to the current density of the gas. Calcia- or yttria-stabilized zirconia has sufficiently good electrical conductivity and thermal shock resistance, but since the conduction mechanism is ionic, it is spoiled by the passage of direct current because of electrolysis. The conductivity of pure monoclinic zirconia is mainly electronic and at 2000°K has a value of about 50 mho/m, but this declines sharply as the temperature falls. Also, the phase change at 1500°K from a monoclinic to tetragonal form, with a concomitant volume shrinkage of 9%, is mechanically destructive and precludes the use of this material for making electrodes. A new ceramic material was designed to overcome these difficulties. A combination of zirconia, a second ceramic (which may be an insulator) and a metal is used. The metal provides electrical conductivity below 1800°K; the second ceramic material acts as a diluent to the zirconia and reduces the effect of the phase change at 1500°K sufficiently to prevent mechanical failure of the material, while the zirconia itself provides the hot electrode surface and the electrical conduction at the high temperature. (BBB)

5199 MHD PLANT, COMBUSTION TECHNIQUES, AND SEEDING. XVI. AIR HEATERS AND SEED RECOVERY FOR MHD PLANT. **Horn, G. (Central Electricity Generating Board Research Labs., Leatherhead, Eng.); Sharp, A. W.; Hryniszak, W. R. Phil. Trans. Roy. Soc. London, Ser. A, 261: 514-40 (July 6, 1967).**

The air heating requirements of a 2000-MW thermal input MHD generating unit are compared with those of current industrial practices. In an open-cycle MHD system that uses coal or oil fuel it is essential to preheat the combustion air to >1200°C if the required flame temperature of 2500°C is to be achieved without the use of additional oxygen. Such a flame temperature is necessary to achieve adequate gas conductivity throughout the generator. Some factors affecting the design of suitable air heaters for the high-temperature stage of this process are discussed and features of 3 general types are described. One is a novel concept in which a circulating stream of molten material is used to transfer heat between hot combustion products and air. Experiments being carried out to provide design data for these 3 types are described and cover the pumping and atomization of high temperature fluids, testing of suitable refractory materials, aerodynamic model studies, and development of refractory seals. Seeding chemicals introduced to enhance gas conductivity pose special problems of corrosion and deposition in the air heaters and investigations into the interdependent processes of heat and mass transfer are described. Since the seed cannot be allowed to escape from the system, studies of recovery processes were also conducted. As the gas cools on its passage through the plant, the seed will separate out and deposit on the heat transfer surfaces. In the highest temperature zones (air heater and water cooled diffuser) the seed will deposit in liquid form and must be removed as in slag-trapped boilers. In cooler zones, solid deposits will form which may be

loose and removable by soot blowers or at worst may combine with fuel ash to form hard bonded deposits. A proportion of the seed will remain in the coolest gas as fume and fine dust and must be removed by filters or electrostatic precipitators before discharge to atmosphere. (BBB)

5200 MHD PLANT, COMBUSTION TECHNIQUES, AND SEEDING. XVII. SOME ASPECTS OF THE CHEMISTRY OF MHD SEED. Hart, A. B.; Laxton, J. W. (Central Electricity Generating Board Research Labs., Leatherhead, Eng.). Phil. Trans. Roy. Soc. London, Ser. A, 261: 541-57(July 6, 1967).

A literature review and results of experiments on the physical chemistry of K_2SO_4 at high temperatures are presented, particularly in terms of the difficulty of evaporating it quickly in an MHD combustion chamber and recovering it after it leaves the generator duct. In oxidizing and neutral gases a 50-μm-dia particle, which could be produced by normal powdering methods, should be evaporated within 10 to 20 msec at 2800°K. Such evaporation should be much faster in reducing gases. Thermodynamic data were used to determine the amount of heat used to evaporate the seed: 6.9% of the calorific value of oil fuel, allowing for seed impurities. A flue gas containing 0.7 at. % K should begin to condense at 1600°K and the amount of liquid, solid, or smoke formed will depend on the rate of removal of heat from the flue gas and on the saturated vapor pressure of K_2SO_4. Accurate data for this pressure determined by effusion and transpiration methods are reported. Potassium sulfate reaching metal tubes in the boiler and superheater may form liquids with excess of sulfur trioxide (including pyrosulfates, melting at about 670°K) in the temperature range 670 to 970°K. This could cause more severe corrosion than when K is absent. Measurements of the partial pressure of K_2SO_4 in equilibrium with coal ash slags up to 2000°K suggested that it should be possible to reject the slag without loss of K if it could be separated from the K-containing gas at 2000 to 2100°K according to the ash content of the coal. (BBB)

5201 MHD PLANT, COMBUSTION TECHNIQUES, AND SEEDING. XVIII. SUPERCONDUCTING MAGNETS FOR MHD GENERATORS. Chester, P. F. (Electricity Council Research Centre, Capenhurst, Eng.). Phil. Trans. Roy. Soc. London, Ser. A, 261: 558-75(July 6, 1967).

The science and technology of superconducting magnets and possibility of their application in large MHD generators are reviewed. Hard superconductors offer, in principle, the most economic means of providing magnetic fields of several tens of kilo-oersteds over large volumes. However, these materials exhibit peculiar behavior when wound into coils (training and degradation) which, until recently, made it impossible to design large coils. The reasons for this, fundamental to hard superconductors, are considered. Some techniques have been developed to reduce these effects, including combination of superconductor with a low resistivity metal, together with the provision of adequate cooling. This circumvents the problem completely. A further problem with large superconducting magnets is to protect the windings, in the event of a coolant failure, against destruction by the release of the stored magnetic energy (10^{10}J) for a large MHD generator magnet. It was shown that this also dictates the use of composite conductors in which the superconductor is the minor component. It is now possible to design windings for large superconducting magnets that will operate predictably, safely, and at the full potential of the superconductor. (BBB)

5202 MHD PLANT, COMBUSTION TECHNIQUES, AND SEEDING. XIX. DISCUSSION. Norris, W. T. (Central Electricity Generating Board Research Labs., Leatherhead, Eng.); Croitoru, Z. Phil. Trans. Roy. Soc. London, Ser. A, 261: 576-9(July 6, 1967).

Calculations are made of the leakage currents that are to be expected flowing directly from one electrode to another when current flows uniformly from infinity in the upper half plane to a row of equilength equispaces plane electrodes on the real axis, and when there is a Hall effect. A transform is given from the Z plane under consideration to a w plane in which effective equipotentials and current flow lines are straight and conditions are undisturbed, or at most uniformly slid, infinitely far from the electrodes. The transform includes θ, the Hall angle, and ψ, the angle between the direction of current flow at infinity and the perpendicular to the electrode line. It was shown that, for given angle of flow of current at infinity as the Hall parameter and angle increase from zero, the leaking current goes through a maximum near $\theta = \frac{1}{4}\pi$. The leakage currents are not large and some typical values are shown for $\psi = 0$, i.e., with current at infinity flowing normally to the electrode row. As ψ increases and the current in the main duct has an axial component opposite to that of the leakage current, the leakage current decreases; as ψ decreases the leakage current increases. Even for quite narrow insulators the leakage current is only a fraction of the net flow to an electrode. It is concluded that electrical performance of generator will be slight, at least as far as fossil fuel fired generators are concerned, where the Hall angle is not close to a right angle. Very heavy current between neighboring electrodes may aggravate itself in a catastrophic way and arcs between adjacent electrodes would harm both the electrodes and the insulator between. The formation of arcs must be avoided but the criterion for their absence is more dependent on other factors, notably interelectrode voltage, than simply on these leakage currents. The preferred shape of MHD generators using semiconducting electrodes is diagrammed. In such generators there are uniform conditions and no additional losses anywhere in the duct. On the other hand, there are additional Joule losses in the semiconducting material. Such losses are unavoidable in a generator demonstrating the Hall effect and having a finite number of load circuits, but these losses are lower than in a segmented generator and have no effect on the internal behavior of the generator. (BBB)

5203 INFLUENCE OF THE GLASS WALL POTENTIAL ON THE CUT-OFF CHARACTERISTIC OF CROSSED-FIELD DEVICES. Bacal, Martha; Cristescu, Maria (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 669-82(1967).

By operating with a plane crossed-field device enclosed in a glass tube two modes of anode current cutoff were observed. Measurements of the glass wall potential showed that the cutoff modes are correlated to the existence of two stable potentials of the wall. The sudden transition from one mode to the other under the effect of the magnetic field is emphasized. The critical value of the magnetic field in the case of an electric field which in addition to a component perpendicular to the cathode has also a tangential component, is presented. (auth)

5204 THERMOELECTRIC GENERATOR. Belofsky, H. (to U. S. Atomic Energy Commission). U. S. Patent 3,357,866. Dec. 12, 1967.

The radioisotope-heated thermoelectric generator described has duplex thermocouple wire wound in a continuous spiral around cold posts, and a cylindrical radioactive heat source whose outside surface is tangent to the inside of the continuous spiral formed by the duplex thermocouple wire, and which is supported from its opposite ends by low-thermal-conductivity resilient mounting means. (AEC)

5205 IMPROVEMENTS IN OR RELATING TO THERMOELECTRIC GENERATORS. (to General Dynamics Corp.). British Patent 1,091,729. Nov. 22, 1967. Priority date Apr. 27, 1965, United States.

A compact thermoelectric generator, which is adapted to operate in inaccessible locations for long periods of time, is described. The lightweight assembly includes an elongated thermopile having a first end and a second end and generates electricity thermoelectrically when the ends are subjected to different respective temperatures. The thermoelements are formed of metallic materials, and the elements in each thermobundle are arranged in compact side by side relationship and are electrically insulated from one another along their lengths. The thermopile includes a resilient adhesive coating binding together the thermoelement pairs into a resilient cylindrical stem with the thermobundles positioned around the circumference of the stem. The housing is hermetically sealed, and the supporting body has rigidity and structural strength so as to support the generator assembly and strengthen the housing. (J.H.M.)

5206 MAGNETOHYDRODYNAMIC GENERATORS. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,091,957. Nov. 22, 1967. Priority date Mar. 11, 1964, Germany.

A compact magnetohydrodynamic generator that is suitable for operation in parallel with other supply systems is described. The generator is designed with a ring-shaped channel in which an electrically conductive fluid flows through a radially-directed magnetic field along a helical path. The axis of the flow path is the central axis of the ring. (J.H.M.)

Fluid Physics

Refer also to abstract 5183.

5207 (MPI-PAE-Extraterr-9/65) UEBER DIE AUSBREITUNG VON KOMPRESSIONSWELLEN IN EINER ISOTHERMEN ATMOSPHAERE MIT VERTIKALEM MAGNETFELD. (Propagation of Compression Waves in an Isothermal Atmosphere with Vertical Magnetic Field). Scholer, Manfred (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). July 1965. 64p. (In German). Dep.

The effect of the energy transfer in the lateral direction on the propagation of a hydrodynamic wave of finite amplitude was investigated and compared with one-dimensional calculations. A vertical magnetic field was then introduced into the calculation. The atmosphere was assumed as an infinitely good electrically conducting medium and the wave propagation was treated within the framework of the magnetohydrodynamic approximation. As in the case without magnetic field the partial nonlinear differential equation system was integrated numerically by an explicit difference method. It was shown that the magnetic field sharply limits the wave in the horizontal direction and guides along the magnetic field line. The results obtained were applied to the solar atmosphere. (J.S.R.)

5208 (NAL-TR-110) SOME INVESTIGATIONS ON INVISCID BOUNDARY LAYER OF MAGNETOHYDRODYNAMICS. Inouye, Kenji (National Aerospace Lab., Tokyo (Japan)). 1966. 18p. Dep.

An inviscid magnetohydrodynamic boundary layer in a steady, two-dimensional, aligned-fields flow of highly conducting incompressible fluid is considered. A pressure number equal to the ratio of magnetic pressure to dynamic pressure appears in this problem. By employing a coordinate transformation analogous to one in conventional viscous boundary-layer problems, a similar solution for the case of a weak magnetic field and an arbitrary outer flow is obtained. For nonvanishing pressure number, a difficulty arises from the fact that the solution of the governing equation has a singularity at the inner edge of the boundary layer. The method of series expansion in pressure number is used to obtain a similar solution, and the coefficients of powers of the pressure number are evaluated to the fourth-power term by integrating numerically the equations satisfied by the coefficients from the outer edge of the boundary layer. As the pressure number increases, the thickness of the boundary layer becomes larger, and the convergence of the solution by series expansion becomes slower. Another numerical solution is obtained by integrating the exact boundary-layer equations directly from the outer edge of the boundary layer. The solutions by series expansion are compared with the solutions by direct integration. Nonexistence of the solution for the case of pressure number greater than unity is shown. (auth)

5209 EXPERIMENTAL INVESTIGATION OF MERCURY FLOW VELOCITY STABILIZATION IN RECTANGULAR DUCT IN THE PRESENCE OF TRANSVERSE MAGNETIC FIELD. Gel'fgat, Yu. M. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 4, 59-65(1967). (In Russian).

Experimental investigation of mercury flow in a rectangular duct in the presence of a transverse magnetic field was carried out. Results of the development and the distortion of the Hartmann velocity profile for various Reynolds and Hartmann number values were obtained. (auth)

5210 RECTANGULAR SECTIONS BETWEEN TWO INDUCTORS OF TRAVELLING MAGNETIC FIELD. HARD INTERACTION. Vilnitis, A. Ya. Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 4, 96-104(1967). (In Russian).

A problem of induction processes in rectangular conducting sections placed between two plane inductors of a travelling magnetic field is presented. Exact solutions of Maxwell's equations are coupled along the boundary of the body; a method of sequential approximations, to settle an infinite system of algebraic equations, is proposed. Expressions for the pressure and magnetic flow from the first approximation, easily applicable in electronic computers, are given. (auth)

5211 AXIAL-SYMMETRIC MIXED FLOW IN MAGNETOHYDRODYNAMICS. Gorskii, V. B. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 5, 64-71(Sept.-Oct. 1967). (In Russian).

The axial-symmetric mixed flow was examined in detail. Precise equations of motion for the rate potential and the current function and corresponding approximation equation of all transition regimes (supersonic, hypercritical, trans-Alfvén, and supersonic-trans-Alfvén regimes) were found. Simple particular solutions of the approximation formulas were obtained. (tr-auth)

5212 SOME MAGNETOHYDRODYNAMIC EFFECTS IN LIQUID CRYSTALS. Ericksen, J. L. (Johns Hopkins Univ., Baltimore). Arch. Ration. Mech. Anal., 23: 266-75(1966).

Analysis of effects which occur when static magnetic fields are imposed on liquid crystals of nematic type, while these undergo simple shearing flow. The analysis given is easily adapted to cases where fluid dielectrics are subject to uniform electric fields. (IAA)

5213 NONEQUILIBRIUM FLOW IN MHD. Morioka, Shigeki (Osaka Univ.). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: Spec. Ed., A1-11(Dec. 1966). (In Japanese).

The influences of the collision term in Boltzmann's equation to the generalized MHD relations are investigated. The approximated expressions for the reaction rate, the radiative loss, the electrical and the thermal conductions, and the effects of these terms to the MHD flow are discussed on the basis of the linearized theory. The reaction rate and the perturbation of the electrical conductivity exert only the secondary effects on the flow, but the radiative loss and the thermal conduction may alter the flow field considerably. (NSA of Japan)

5214 CERTAIN TWO-DIMENSIONAL FLOW AT FINITE MAGNETIC REYNOLD'S NUMBERS. Eliseev, B. V.; Lobanov, A. D. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 14-20(Jan.-Feb. 1967). (In Russian).

A mathematical analysis was made of a magnetohydrodynamic flow at finite Reynolds' magnetic number. The distribution of the current was determined, and the current component of the Lorentz force in the two-dimensional channel, with electrodes, was evaluated. The effects of velocity changes on the current flow of the incompressible fluid were studied in the case of large magnetic Reynolds' numbers. (tr-auth)

5215 STABILITY OF NON-ISOTHERMAL PLASMA FLOW IN A PLANE MAGNETOHYDRODYNAMIC CHANNEL. Sanochkin, Yu. V. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 3-7(Jan.-Feb. 1967). (In Russian).

A problem on hydrodynamic stability of nonisothermal plasma flow in steady crossed electric and magnetic fields in a plane channel confined by dielectric walls was studied. The solution of the system of equations obtained for the perturbations considering all instability mechanisms proved to be exceedingly complex. A general system of equations was developed for two maximum cases of superheated and hydrodynamic instabilities. (R.V.J.)

Geophysics

Refer also to abstracts 4587, 4939, and 5177.

5216 (CLM-Trans-9) H-FUNCTIONS IN RESONANCE-RADIATION TRANSFER THEORY. Ivanov, V. V.; Nagirner, D. I. Translated for U.K.A.E.A., Culham Lab., Abingdon, Eng., from Astrofizika, 1: 143-66(1965). 17p. Dep. CFSTI. UK 2s. 6d. JCL $1.60 fs, $0.80 mf.

The transfer of radiation in a Doppler-broadened resonance line is investigated. A semi-infinite atmosphere is considered with negligibly small absorption in the continuous spectrum, using the approximation of complete frequency redistribution. (auth)

5217 (NRC-TT-1302) DETERMINATION OF EXTINCTION IN THE EARTH'S ATMOSPHERE AT WAVELENGTHS OF 20 AND 3.2 cm. Fuerstenberg, F. Translated by D. A. Sinclair (National Research Council of Canada, Ottawa), from Z. Astrophys., 49: 42-60(1960). 20p. Dep. CFSTI. CAN.

As part of a general program of absolute measurements of radiation from extraterrestrial sources, the atmospheric damping is determined experimentally for wavelengths of 20 cm and 3.2 cm by measurements of solar radiation in the vicinity of the horizon, and the results are examined for regularities. The increase of extinction with the zenith angle conforms to Bemporad's equation for the optical region. Extended series of tests gave mean values of 0.072 db for $\lambda = 20$ cm and 0.084 db for $\lambda = 3.2$ cm for extinction over the whole distance through the atmosphere at perpendicular incidence. (auth)

5218 TEMPERATURE OF NEUTRAL AND CHARGED PARTICLES IN THE IONOSPHERE AND MAGNETOSPHERE (RESULTS OF MEASUREMENTS ON ROCKETS AND SATELLITES). Gringauz, K. I. (Radiotechnical Inst., Moscow). Usp. Fiz. Nauk, 92: 207-28(June 1967). (In Russian).

A review is presented of available data on the temperature of neutral particles (T_g), electrons (T_e), and ions (T_i) in the earth's atmosphere, as obtained with equipment mounted on rockets and satellites. The methodology is discussed only briefly, and the bulk of the article is devoted to the results obtained by various workers and to their interpretation. No use is made of data obtained by measurements with land-based equipment. It is deduced from the results that the most reliable are the numerous direct measurements of T_g made with the aid of mass spectrometers and by observing the fluorescence of K, Na, and Al_2O_3. Almost all the measured values of T_g increase with altitude in the range from 100 to ~200 km. The dependence of T_g on the intensity of the

solar short-wave radiation increases with altitude up to ~300 km. Measurements of T_i are quite scanty. The daytime values of T_i at altitudes 200 to 600 km are lower than those of T_e. Measurements of T_e are more numerous and exhibit a dependence on the altitude and on the solar activity, but the exact dependence has not yet been determined. T_e increases in magnetic disturbances and also has a diurnal variation with a peak near sunrise. This peak decreases with increasing altitude. T_e has a maximum near the geomagnetic equator and also maxima near 40°N and 50°S. The latter shift towards higher latitudes at night. Other features of the temperatures are also discussed. (ATD)

5219 N–h PROFILES FOR THE IONOSPHERE OVER HYDERABAD. Rao, E. Bhagiratha; Murty, Ch. Satyanarayana (Defence Electronics Research Lab., Hyderabad, India). Indian J. Pure Appl. Phys., 5: 226-31(June 1967).

The h′ –f traces taken at Hyderabad during the period May 1963 to April 1964 have been reduced to electron density-true height profiles following the method of Schmerling and utilizing the Schmerling and Ventrice coefficients appropriate to the dip angle at Hyderabad. The adaptation of this method to manually obtained h′ –f traces with reference to any errors occurring during the reduction process is discussed. The results of this true height analysis are averaged for each season, and the variation of $N_m F2$, the maximum electron density of the F2 region, and $h_m F2$, the height of maximum ionization of F2 region, is discussed. N–t curves and iso-N contours have been given for summer, winter and equinox periods. The subpeak electron content n_t is evaluated and its variation for the three seasons is analyzed. (auth)

5220 PARTIAL COROTATION OF A MAGNETIZED PLASMA. Alfven, Hannes (Royal Inst. of Technol., Stockholm). Icarus, 7: 387-93(Nov. 1967).

The possible presence of electric fields parallel to the magnetic field in planetary magnetospheres limits the applicability of the "frozen-in" picture of magnetic field lines. A plasma situated in the magnetic field from a rotating celestial body need not necessarily obey Ferraro's law of isorotation. A state of "partial corotation" is also possible. The results are applied to some cosmogenic problems. It is of interest to investigate to what extent the magnetosphere corotates with the Earth. (auth)

5221 DAYTIME OBSERVATIONS OF ENERGETIC AURORAL-ZONE ELECTRONS. Lampton, M. (Univ. of California, Berkeley). J. Geophys. Res., 72: 5817-23(Dec. 1, 1967).

Daytime electron precipitation was observed from onboard Nike Apache sounding rockets launched from Fort Churchill, Manitoba, Canada. Energy spectra and pitch-angle distributions are presented. Rapid time variations are seen at energies greater than 60 keV, and travel time arguments indicate that the precipitation cause acts within a few R_E of the earth. (auth)

5222 THE RELATIONSHIP BETWEEN POLAR MAGNETIC ACTIVITY DP AND GROWTH OF THE GEOMAGNETIC RING CURRENT. Davis, T. N.; Parthasarathy, R. (Univ. of Alaska, College). Contract NAS5-3595. J. Geophys. Res., 72: 5825-36(Dec. 1, 1967).

Analysis of equatorial and polar region magnetograms reveals that there is an impulsive injection of energy into the geomagnetic ring current and that the impulsive injection exhibits a temporal behavior similar to DP substorm activity but usually lags it by one or more hours. Based upon observations of Dst at low latitude, a method is developed for the determination of the rate of energy injection into the ring current as a function of time. In obtaining this rate, a knowledge of the rate of decay of the ring current is necessary; a determination of that decay rate is made here. It is found that the magnitude of the main phase of a magnetic storm correlates with the integrated DP activity during the 10 hours preceding the maximum excursion of Dst, independent of whether the magnetic storm commences gradually or is preceded by a storm sudden commencement. The results presented here lead to the conclusion that the energetic particles responsible for the DP activity and the growth of the ring current simultaneously emerge in a burst-like manner from a source of holding region outside the Van Allen belts; during such injections, some of the particles travel along the magnetic field to the auroral zones to give rise to DP and related activity there, while others diffuse radially inward to the Van Allen belts and arrive there, often with a delay of one or more hours. (auth)

5223 TEMPERATURE AND COMPOSITION OF THE EQUATORIAL IONOSPHERE. Farley, D. T.; McClure, J. P.; Sterling, D. L.; Green, J. L. (Jicamarca Radar Observatory, Lima). J. Geophys. Res., 72: 5837-51(Dec. 1, 1967).

Values of temperature and composition obtained from incoherent scattering measurements in December 1965 and March–May 1966 at Jicamarca are presented. These values are derived from the autocorrelation function of the scattered signal, and the method by which this function is measured and analyzed is discussed in some detail. The temperature results differ considerably from those of temperate latitudes. During the day, the electron temperature reached a maximum value of the order of 1500 to 2000°K near 220 to 250 km, then decreased, arriving at equilibrium with the ion temperature somewhat above 300 km. Above 400 to 500 km, both the ion and electron temperatures increased, sometimes reaching values of the order of 2000°K at the highest heights observed (800 to 1000 km). During sunrise, the electron temperatures often exceeded 3000°K near 400 km. At sunset, the electrons and ions quickly reached equilibrium, and the ionosphere became isothermal at temperatures that sometimes fell slightly below 600°K. The altitude at which the O^+ concentration fell to 50% of the total varied between 600 and 800 km in December 1965, and between 650 and 1100 km in March–April 1966. (auth)

5224 RECOMBINATION COEFFICIENT AND CORONAL CONTRIBUTION TO E-LAYER IONIZATION FROM MAGNETIC OBSERVATIONS OF A SOLAR ECLIPSE. Bomke, Hans A.; Blake, Henry A.; Harris, Arthur K.; Hulse, William H.; Sheppard, Duane J. (Army Electronics Command, Fort Monmouth, N. J.). J. Geophys. Res., 72: 5913-18(Dec. 1, 1967).

The horizontal component of the geomagnetic field, measured on the ground at two stations near the path of totality, reached the greatest departure from its normal value shortly after maximum eclipse in the nearby E region. The magnitude of this departure is consistent with the generally accepted hypothesis that the eclipse-induced current system is located near the 100-km level. A determination was made of the lag from the time when the E-region eclipse occurred at the theoretically optimum location until the time of maximum observed magnetic effect, with corrections for induction delays. Using this time lag, along with the observed decrease in the E region ionization, the effective ion-recombination coefficient and the percentage of ionizing radiation remaining at totality were determined. The recombination coefficient was found to be 5.5 (±1) × 10^{-8} cm^3 sec^{-1} and the residual coronal radiation 15 (±3)%. (auth)

5225 CHANGES IN VAN ALLEN RADIATION ASSOCIATED WITH POLAR SUBSTORMS. Jelly, Doris (Defence Research Board, Ottawa); Brice, Neil. J. Geophys. Res., 72: 5919-31(Dec. 1, 1967).

Previous work has shown that precipitation of energetic electrons at auroral-zone latitudes shows two maxima, one just before midnight for soft (low-energy) electrons associated with substorms and one for harder particles in the morning hours. It is concluded from the present study that increases in precipitation in these two regions frequently show a one-to-one correspondence. The maximum flux of semitrapped electrons ($E \geq 40$ keV) measured by the Alouette-1 satellite in the morning hours is larger on the average by a factor of about 5 shortly after the onset of a nighttime negative bay on the magnetometer compared with shortly before. The morning cosmic noise (riometer) absorption also increases by an average of about 1 db after the onset of a nighttime polar substorm. The association found here between phenomena at widely separated longitudes strongly indicates that auroral precipitation is not a spatially isolated phenomenon, but is intimately connected with large-scale processes that occupy a substantial part of the magnetosphere. These large-scale disturbances are often isolated in time, and for such events the term elementary magnetospheric substorm (EMS) is suggested. It is found that nighttime substorms that are not associated with morning precipitation more often follow magnetically quiet conditions (during the previous 12 hours) than disturbed conditions. This observation has been interpreted as being consistent with the existence of a maximum flux limit for stably trapped energetic electrons. (auth)

5226 MASS SPECTROMETRIC MEASUREMENTS OF ATOMIC OXYGEN IN THE UPPER ATMOSPHERE: A CRITICAL REVIEW. von Zahn, U. (Univ., Bonn). J. Geophys. Res., 72: 5933-7(Dec. 1, 1967).

Mass spectrometric measurements of the composition of the neutral atmosphere at 120-km altitude are surveyed. Measured argon abundances imply a height of the turbopause of about 105 km and an eddy diffusion coefficient of 1×10^6 cm^2/sec. These values, however, would imply a ratio $n(O_1)/n(O_2)$ of about 4 at 120 km, whereas mass spectrometers have measured repeatedly approximately 1. Evidence is presented that in mass spectrometer ion sources considerable loss of atomic oxygen occurs by both trapping at the walls and recombination to N_2O or CO_2. However, those atoms and molecules that are reflected at least once from an ion source wall contribute by far the largest percentage to the measured ion currents in all rocket-borne mass spectrometers. Hence it seems not impossible that all mass

spectrometric determinations of atomic oxygen at 120-km altitude are indeed too low by a considerable margin. (auth)

5227 ION TEMPERATURE AND RELATIVE ION COMPOSITION MEASUREMENTS FROM A LOW-ALTITUDE POLAR-ORBITING SATELLITE. Harris, K. K.; Sharp, G. W.; Knudsen, W. C. (Lockheed Palo Alto Research Lab., Calif.). J. Geophys. Res., 72: 5939-48(Dec. 1, 1967).

An ion energy analyzer was flown on a recent (November 9–11, 1965) low-altitude polar-orbiting satellite. The data were collected, partially analyzed while in flight by the instrument, and stored on tape to be read out at convenient satellite tracking stations. The data sampling rate was once every three seconds, which permitted a very detailed measure of the latitude variation of ion temperature, concentration, and relative ion composition. Large temperature fluctuations were observed in the nighttime northern high-latitude regions. Midlatitude daytime ion temperatures generally varied between 400 and 1000°K. High temperatures were observed in both the daytime southern auroral zone and the nighttime northern auroral zone. The midlatitude trough in ion concentration was observed at L = 4.5, while other sharp troughs were located at about L = 1.5. (auth)

5228 SCATTERING OF PARTICLES BY WAVES IN THE PRESENCE OF A MAGNETIC FIELD. Eviatar, Aharon (Bell Telephone Labs., Murray Hill, N. J.). J. Geophys. Res., 72: 5997-6012(Dec. 1, 1967).

The Balescu–Lenard kinetic equation is generalized to include the effects of a constant magnetic field and transverse radiation. A Fokker–Planck equation is derived from it and applied to the scattering of Van Allen electrons by transverse waves propagating along the magnetic field. The 90° deflection time is estimated in terms of the Fokker–Planck dispersion coefficient and used to interpret trans-L diffusion observations. Conditions under which the scattering by electromagnetic radiation can compete with electrostatic plasma oscillations are formulated. (auth)

5229 EFFECTIVE VISCOSITY OF A STREAMING COLLISION-FREE PLASMA IN A WEAKLY TURBULENT MAGNETIC FIELD. Tsuda, Takao (Stanford Univ., Calif.). J. Geophys. Res., 72: 6013-20(Dec. 1, 1967).

Fokker–Planck analysis is made of the effective viscosity of a streaming collision-free plasma in a weakly turbulent magnetic field. This viscosity is an effect of momentum transfer across the stream due to the scattering of guiding centers of charged particles by coherent magnetic field fluctuations of the hydromagnetic type. In the slow-stream approximation, which is pertinent to the upstream face of the magnetosphere, the electric field accompanying magnetosonic fluctuations can play the main role in the viscous interaction. It is concluded that there is most probably a viscous-like interaction between the solar wind and the magnetosphere. (auth)

5230 OUTWARD FLOW OF PLASMA IN THE MAGNETOTAIL FOLLOWING GEOMAGNETIC BAYS. Hones, E. W. Jr.; Asbridge, J. R.; Bame, S. J.; Strong, I. B. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res., 72: 5879-92(Dec. 1, 1967).

A study of electrons in the Earth's magnetosphere, measured by the Vela-2 satellites, and of magnetograms from high-latitude stations on the Earth has revealed that hot plasma containing electrons of energy >45 keV often arrives suddenly in the plasma sheet of the magnetotail at the peak or during the recovery phase of a negative magnetic bay in the auroral zone. It is found also that if a satellite is in the plasma sheet at the time a negative bay starts, it is likely to detect a decrease in the intensity and/or the average energy of the electrons there as the depth of the bay increases. These observations suggest that a contraction of the plasma sheet occurs during the development of a bay, followed by a sudden expansion starting at the beginning of bay recovery. It is concluded that the bursts of hot plasma in the magnetotail derive their energy from processes occurring inside the Vela satellite orbit (radial distance ~17 R_E). The relevance of these observations to models of the magnetosphere is discussed. (auth)

5231 TEMPORAL VARIATIONS IN THE ELECTRON FLUX AT SYNCHRONOUS ALTITUDES. Lanzerotti, L. J.; Roberts, C. S.; Brown, W. L. (Bell Telephone Labs., Murray Hill, N. J.). J. Geophys. Res., 72: 5893-5902(Dec. 1, 1967).

A six-element solid-state detector telescope sensitive to electrons and heavier particles has been flown on the synchronous orbit ATS-1 satellite. Electron data from the experiment for the time period from day 351, 1966, through day 2, 1967 are discussed. The electron data for electron energies ranging from about 0.4 to 2 MeV show a diurnal effect in the intensity with a minimum near local midnight. The electron spectrum is generally softer on the night side. The magnitude of the diurnal effect is frequently a factor of 10 for 1.5-MeV electrons and appears to increase with an increase in the magnetic index K_p. The diurnal effect in the electron flux is qualitatively explained by considering a distorted dipole model of the Earth's magnetic field. On several occasions electron oscillations with 7- to 25-min periods have been observed in the data. From a simplified analysis of the oscillation periods as a function of electron energy we attribute the oscillations to the longitudinal drift of bunches of electrons. (auth)

5232 EXPLORER 35 PLASMA MEASUREMENTS IN THE VICINITY OF THE MOON. Lyon, E. F.; Bridge, H. S.; Binsack, J. H. (Massachusetts Inst. of Tech., Cambridge). Contract NAS5-9078. J. Geophys. Res., 72: 6113-17(Dec. 1, 1967).

Some initial conclusions about the influence of the Moon on the flow of charged solar-wind particles are reported. The conclusions are based on early plasma measurements obtained by the M.I.T. Faraday-cup-type detector flown on Explorer 35. (J.H.M.)

5233 HIGHER ORDER RING CURRENTS AND PARTICLE ENERGY STORAGE IN THE MAGNETOSPHERE. Hoffman, R. A.; Brachen, P. A. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 6039-49(Dec. 1, 1967).

A system of computer programs has been developed to calculate by successive approximations the ring current magnetic field to any order from an arbitrarily defined distribution of particles in any field model. Using a field model containing the boundary and neutral sheet fields in addition to the main field, third-order ring current fields have been calculated for various enhancements of a reasonable particle distribution model. A number of properties of high intensity ring currents have been investigated including the following. (1) Diamagnetism alone poorly describes the field deformation in the heart of the ring current region. (2) In spite of the inclusion of particle energy densities reaching twice the ambient field energy density, the total magnetic field is not inordinately distorted. Self-consistent solutions are easily obtained, and a null point in the field appears difficult to reach. (3) The ratio of particle energy density to final field energy density, β, has been considered. It is shown that very large particle energy densities will not themselves provide the limitation on β by obliterating the field. Therefore, it is required of dynamic mechanisms to quantitatively place the upper limits on β. (auth)

5234 AVERAGE STRUCTURE AND STORM-TIME CHANGE OF THE POLAR TOPSIDE IONOSPHERE AT SUNSPOT MINIMUM. Nishida, Atsuhiro (Tokyo Univ.). J. Geophys. Res., 72: 6051-61(Dec. 1, 1967).

A synoptic model of the topside ionosphere above 40°N at sunspot minimum is constructed by statistically summarizing more than 3000 Alouette 1 N–h profiles obtained in 1962, 1963, and 1964 during geomagnetically quiet intervals. The characteristic features of "polar peak," "auroral peak," "trough," "winter spur," and "midlatitude evening increase" are shown. The storm-time change is derived by comparing a storm-time (K_p = 9–) profile with the average quiet-interval profile. Physical explanations are discussed with emphasis on the role of ionospheric drift and plasma escape from the magnetospheric tail. (auth)

5235 CURRENT SYSTEM OF GEOMAGNETIC BAYS. Atkinson, G. (California Inst. of Tech., Pasadena). Contract NAS7-100. J. Geophys. Res., 72: 6063-7(Dec. 1, 1967).

It has been suggested that the observed magnetic deflection during a geomagnetic bay is the superposition of magnetic effects of the Hall current system, and the westward electrojet, which is current flowing down field lines from the outer magnetosphere, along the high conductivity strip at the base of the auroral arcs and up field lines into the outer magnetosphere. A theoretically predicted flux tube flow that agrees with the observed motions is used to predict the magnetic fluctuations at the Earth's surface and gives good agreement with observation. It is found that the vertical currents are important in determining regions of positive and negative bays. (auth)

5236 RADIAL DIFFUSION OF TRAPPED PARTICLES WITH ARBITRARY PITCH ANGLE. Conrath, Barney J. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 6069-76(Dec. 1, 1967).

The radial diffusion of trapped particles due to magnetic disturbances of a large spatial scale is investigated. Earlier efforts on this problem have been confined to particles mirroring in the equatorial plane. Particles of arbitrary pitch angle are considered. An expression is derived for the mean square change in L value per unit time, and it is found that the efficiency of the diffusion process is in general a function of both particle energy and pitch angle, with the specific dependence being determined by the behavior of the power spectrum of the asymmetric component of the magnetic disturbances. Two particular models are considered that can pro-

duce an enhanced diffusion of particles with pitch angles near 90°. However, for power spectra that decrease sufficiently rapidly with frequency, enhanced diffusion of particles at lower pitch angles can be obtained. (auth)

5237 VLF PHASE PERTURBATIONS PRODUCED BY SOLAR PROTONS IN THE EVENT OF FEBRUARY 5, 1965. Potemra, T. A.; Zmuda, A. J.; Haave, C. R.; Shaw, B. W. (Johns Hopkins Univ., Silver Spring, Md.). Contract NOw-62-0604-c. J. Geophys. Res., 72: 6077-89(Dec. 1, 1967).

Solar protons in the event of February 5, 1965, caused day and nighttime phase disturbances in the 18.6-khz vlf transmission between station NLK in Jim Creek, Washington, and Thule, Greenland. The phase anomalies persisted for three days with a maximum deviation of 20 μsec, representing 67% of the total normal diurnal variation. A quantitative connection is made between the observed vlf phase variations and the solar protons measured by satellites in the near-earth environment by means of specific ionosphere and vlf propagation models. The lower ionosphere is described by effective recombination coefficients, α_{eff}'s, appropriate to day and nighttime ionization conditions. The effective vlf reflecting height of a sharply bounded ionosphere is located at the altitude where the ionospheric conductivity parameter ω_r equals 2.5×10^5 sec^{-1}. The vlf variations are also explicable by an exponential ionosphere with a reference height equal to the effective reflecting height of the sharply bounded model. An integral flux of 150 protons/cm^2 sec with $E \geq 20$ MeV produced a daytime lowering of the vlf reflecting height by 10 km. The ionization model of the lower ionosphere derived in relation to the vlf is used to compute daytime riometer absorption that fits well to the absorption measured at McMurdo Sound, Antarctica, at 30 Mhz, but not as well at 50 Mhz. (auth)

5238 INTERACTION OF THE NEUTRAL HYDROGEN AND CHARGED PARTICLES IN THE RADIATION BELTS: THE CONSEQUENT LYMAN-ALPHA EMISSION Kondo, Yoji; Kupperian, James E. Jr. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 6091-7(Dec. 1, 1967).

The observations obtained by rocket-borne instruments carried to the altitude of about 120 km or higher at White Sands, New Mexico, suggest that there exists a directional variation of the Lyman-α intensity that is correlated with the geomagnetic field. This correlation consists of three features: namely (1) the general increase of the flux in the direction of the geomagnetic north pole and the general decrease in the direction of the geomagnetic equator; (2) a trough of lower intensity along the geomagnetic dipole plane containing the observer's geomagnetic zenith; and (3) the symmetric increase of the flux on both sides of the trough. Also, the direction of decrease does not agree with the antisolar direction, as was previously thought. This suggests an association of the Lyman-α emission with the Van Allen radiation belts. New interpretation proposed in the study principally attributes the diffused nighttime Lyman-α radiation to the collision between the neutral hydrogen atoms and the charged particles in the radiation belts, though there will be some contribution from the scattered solar Lyman-α photons and the Lyman-α photons of interstellar origin. (auth)

5239 SOLAR FLARE EFFECTS IN THE IONOSPHERE. Garriott, Owen K.; da Rosa, Aldo V.; Davis, Michael J.; Villard, O. G. Jr. (Stanford Univ., Calif.). Contract NAS5-10102. J. Geophys. Res., 72: 6099-6103(Dec. 1, 1967).

Increases in columnar electron content of the ionosphere were observed at four or at five stations, simultaneously with the onset of solar flares on May 21 and 23, 1967. Time-correlated values of visual brightness at the center of the H_α line, radio noise, radio wave absorption, and other phenomena are shown. An estimate of the wavelength range and energy flux of the ionizing radiation required to produce these effects is obtained. (J.H.M.)

5240 SOME REMARKS ON THE POSITION AND SHAPE OF THE NEUTRAL SHEET. Russell, Christopher T.; Brody, Kenneth I. (Univ. of California, Los Angeles). Contract NAS7-100. J. Geophys. Res., 72: 6104-6(Dec. 1, 1967).

Methods for determining the position and shape of the neutral sheet of the geomagnetic tail are discussed. Existing measurements suggest a formula for the location of the neutral sheet in the geocentric solar magnetospheric coordinate system. This formula is discussed, and it is concluded that the formula is useful in studying phenomena in the tail. Data indicate that it is necessary to know the direction and velocity of the solar wind outside the tail in order to determine the position and shape of the neutral sheet. (J.H.M.)

5241 RELATIONSHIP BETWEEN CHANGES IN THE INTERPLANETARY MAGNETIC FIELD AND VARIATIONS IN THE MAGNETIC FIELD AT THE EARTH'S SURFACE. Rostoker, G.; Faelthammar, C.-G. (Royal Inst. of Tech., Stockholm). J. Geophys. Res., 72: 5853-63(Dec. 1, 1967).

Hourly average values of solar wind velocity and the components of the interplanetary magnetic field obtained by IMP 1 were combined to obtain the interplanetary electric field as measured in a coordinate system with one axis parallel to the Earth's magnetic dipole axis. The hourly values of the azimuthal component of the interplanetary electric field were related to the different types of magnetic activity observed at a worldwide chain of stations. It is found that a positive increment in the azimuthal electric field (enhancement of the southward directed interplanetary magnetic field) is strongly related to the initiation of magnetic bay and storm activity, and that establishment of a negative (or less positive) azimuthal electric field during the course of a storm or bay is associated with the start of the recovery phase. Sudden impulses are shown to be equally often associated with negative and positive increments in the azimuthal electric field and are found to be the most common event observed. The combinations of solar–terrestrial parameters that appear to determine the different types of magnetic activity are discussed in the light of the results presented. (auth)

5242 ELECTROMAGNETIC WAVE INTERACTIONS WITH A MOVING IONIZING SHOCK. Chen, C. P.; Hughes, W. F. (Carnegie Inst. of Tech., Pittsburgh). J. Geophys. Res., 72: 6021-37 (Dec. 1, 1967).

The interactions of transverse waves (electromagnetic or magnetohydrodynamic) with a moving ionizing shock in the presence of a magnetic field are investigated. The dispersion equation is derived, and the reflection coefficients and transmission coefficients are found including relativistic effects. The permeability and permittivity of the ionized gas are allowed to be arbitrary. The wave is considered for an arbitrary angle of incidence if it is initiated in the un-ionized gas region. There will be a wave reflected from the boundary and two modes of waves transmitted into the ionized gas. It is found that for interaction with a normal shock the propagation constants of the transmitted waves in the ionized gas are independent of the polarization and the direction of propagation of the incident electromagnetic wave. When the wave is initiated in the ionized gas region, two modes of waves will be reflected from the boundary and one transmitted into the un-ionized gas. (auth)

5243 SOLAR WIND AND THE TEMPERATURE FIELD OF THE TROPOSPHERE. Smirnov, R. V. (Marine Hydrophysical Inst., Kiev). Dokl. Akad. Nauk SSSR, 175: 76-9(July 1, 1967). (In Russian).

The velocities of solar wind, temperature values for various periods (day, night, 24-hour average), and height of the tropopause are studied. Comparisons show that for the period studied (September–October 1962) there is a definite relation between variations in solar wind velocity and the temperature of the lower layer of the troposphere. Many examples of coincidence between temperature minimums and increase in solar wind velocity were noted. From a comparison of temperature curves for daytime, nighttime, and average 24-hour periods, it is seen that the solar effect appears first in the lighted hemisphere, then in the dark hemisphere. Preliminary comparisons of changes in meteorological parameters at several pressure levels with solar wind velocity show that changes in temperature and height of the isobaric surface occur in phase in some regions, but in opposite phases elsewhere. It is possible that tropospheric processes are affected not so much by absolute values of solar wind velocity as by its time derivative. (ATD)

5244 DIRECT OBSERVATIONS OF THE IONOSPHERE BY SOUNDING ROCKETS: RESULTS OF CHARGED PARTICLE DENSITY MEASUREMENTS DURING IQSY. Miyazaki, Shigeru; Oshio, Mitsuo; Hirao, Kunio (Tokyo Univ.). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: 1040-64(Sept. 1966). (In Japanese).

Discussion of 11 direct observations of the charged particle density of the ionosphere, made at Kagoshima Space Center during the IQSY (January 1964 to December 1965). The resonance probe method and the Langmuir probe method were used for the electron density measurements, and the ion trap and Langmuir probe methods were used for the positive ion density measurements. (TSS)

5245 POSSIBLE PARTICLE MEASUREMENTS IN THE HIGH-LATITUDE MAGNETOSPHERE. Hoffman, R. A. (Goddard Space Flight Center, Greenbelt, Md.). Space Sci. Rev., 7: 302-13(Oct. 1967).

A few high-latitude experiments for particle measurements in the magnetosphere are outlined. Consideration is given to the necessity for a close cooperation between the experimeters and the spacecraft designers in order to produce a payload which can accomplish the scientific objectives of the mission. (J.H.M.)

5246 IONOSPHERIC ELECTRON CONTENT AND THE [O I] 6300 A NIGHTGLOW. Brown, W. E.; Steiger, W. R. (Univ. of Hawaii, Honolulu). Nature (London), 216: 47(Oct. 7, 1967).

The electron content of the ionosphere is being measured by the Faraday rotation of vhf signals from the synchronous satellite Syncom III every 5 min. The intensity of the 6300 Å emission is also measured every 5 min. during the night. An altitude of 250 km was chosen, at the base of the night-time F region and near the height of peak emission rate of the [O I] 6300/6364 Å airglow. Contaminating continuum radiation is eliminated by the so-called two-colour method. Observations made on the night of Jan. 6/7, 1967, are shown graphically. The large night-time increases in airglow intensity are peculiar to the tropics, and results obtained show that they are preceded by nocturnal increases in electron content. It is inferred that about 0.15 quantum is produced for each electron lost in the night-time ionosphere, including both the 6300 and 6364 Å emission features. The tropical nightglow has several morphological aspects in common with those of the so-called equatorial anomaly of the F region. This implies that the explanation of the nocturnal increases in electron content is to be found in the peculiar ionisation distributions and motions found in the tropics, and not by invoking a night-time ionising agent. (U.K.)

5247 TREND OF THE AMOUNT OF WINTER ANOMALY OF IONOSPHERIC ABSORPTION FROM 1956 TO 1966. Schwentek, H. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). J. Atmos. Terrest. Phys., 29: 1169-73(Sept. 1967).

From measurements of ionospheric absorption by means of field strength recording in the period 1956 to 1966, the amount of winter anomaly was derived; it is presented as a function of time in winter and shows a fairly regular trend, with the exception that in January and February the amount is still larger. (auth) (UK)

5248 EARLY RESULTS FROM THE MAGNETIC FIELD EXPERIMENT ON LUNAR EXPLORER 35. Ness, N. F.; Behannon, K. W.; Scearce, C. S.; Cantarano, S. C. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 5769-78(Dec. 1, 1967).

Explorer 35 was injected into a selenocentric orbit on July 22, 1967. Analysis of measurements near periselene (800 km from the lunar surface) while the moon is within the geomagnetic tail suggests that the moon is not magnetized and that its moment is less than 4×10^{20} cgs units ($<10^{-5}$ of the earth). Rapid diffusion of interplanetary magnetic field lines through the lunar body limits the effective average electrical conductivity to a maximum value of 10^{-5} mho/m. Thus capture of interplanetary magnetic field lines by the moon and formation of a lunar magnetosphere as theorized by Gold is not substantiated. A lunar bow shock wave has not yet been observed when the moon is located in the interplanetary medium or the magnetosheath of the earth. (auth)

5249 GEOMAGNETICALLY TRAPPED ALPHA PARTICLES. Krimigis, S. M.; Van Allen, J. A. (Univ. of Iowa, Iowa City). J. Geophys. Res., 72: 5779-97(Dec. 1, 1967).

Observations reported were made with the University of Iowa Injun-4 satellite that was launched on November 21, 1964, into a nearly polar orbit of 81° inclination with initial apogee and perigee altitudes of 2502 and 527 km, respectively. It carried a 25-micron thick, totally depleted silicon surface barrier detector with four electronic discrimination levels. The two lower levels are sensitive to protons $0.52 \leq E_p \leq 4.0$ MeV and $0.90 \leq E_p \leq 1.8$ MeV, respectively. The two upper levels are sensitive only to nuclei heavier than deuterons and, specifically, are sensitive to α particles $2.09 \leq E_\alpha \leq 15$ MeV and $3.89 \leq E_\alpha \leq 7$ MeV, respectively. Study of the available data up to April 17, 1965, leads to the following conclusions: (a) The presence of geomagnetically trapped α particles is established. (b) At constant $|B| \approx 0.19$ gauss the maximum intensity perpendicular to B occurs at L = 3.1. The absolute directional intensity there is $j_\alpha(E_\alpha > 2.09$ MeV) = 28 (cm^2 sec ster)$^{-1}$ and $j_\alpha(E_\alpha > 3.89$ MeV) = 4.5 (cm^2 sec ster)$^{-1}$. (c) At this outer-zone maximum, the ratio of the directional intensities of α particles and of protons, both integrated above the common value $E_\alpha = E_p = 0.52$ MeV/nucleon, is $j_\alpha/j_p = (2.3 \pm 0.2) \times 10^{-4}$. (d) A variety of considerations, no one of which is decisive, suggests that the most physically significant form of the spectra of α particles and protons may be an exponential one in terms of energy/nucleon. (e) It appears conceivable that the observed ratio j_α/j_p may be reconcilable with a solar-wind-source of outer-zone protons and α particles although this ratio is significantly less than that predicted from diffusion theory with known loss processes taken into account. (f) The distribution of outer-zone α particles was changed markedly after the magnetic storm of April 18, 1965, and the intensity peak moving inward from L = 3.1 to L = 2.9. (g) Trapped α particles in the inner zone are apparently due to a different source from that for those in the outer zone. (auth)

5250 MODEL OF THE EQUATORIAL ELECTROJET INVOLVING MERIDIONAL CURRENTS. Untiedt, J. (Technische Universitaet, Brunswick). J. Geophys. Res., 72: 5799-5810 (Dec. 1, 1967).

A numerical two-dimensional model of the equatorial electrojet has been calculated that fully allows for meridional ionospheric currents. This model yields stronger currents and a substantially larger width of the electrojet than are indicated by previous models that are based on the layer conductivity σ_{yy}, and neglect meridional currents. The results of the calculation are in satisfying accordance with ground-based measurements of the electrojet magnetic field, as well as with the latitudinal cross section of ionospheric current density as derived from rocket investigations, and with radar observations of field-aligned irregularities at the magnetic equator. In addition, the model yields a toroidal magnetic field that is generated by the meridional currents and whose intensity is equal to that of the electrojet field observable at ground level. Modifications of the model show that large-scale N–S winds may cause observable asymmetries of the electrojet with respect to the magnetic equator, whereas the influence of E–W winds is negligible. The latter also holds for a horizontal electric field transverse to the magnetic equator. (auth)

5251 ENERGY AND FLUX VARIATIONS OF NEARLY MONOENERGETIC AURORAL ELECTRONS. Albert, Richard D. (Univ. of California, Berkeley). J. Geophys. Res., 72: 5811-15(Dec. 1, 1967).

Nearly monoenergetic spectra observed during a visible aurora indicated an energy shift toward higher energy that was apparently due to the changing latitude of observation during the rocket flight. The results are consistent with the presence of a polar electric field having a magnitude of about 55 mV/meter. The data indicate that the electron fluxes are being energized by an electric field mechanism that accounts for most of the energy required to excite the visible radiation observed during the event. The electrons do not appear to be mirroring on closed magnetic lines of force. (auth)

5252 SCHUMANN RESONANCES AND ELF PROPAGATION FOR INHOMOGENEOUS, ISOTROPIC IONOSPHERE PROFILES. Jones, D. Llanwyn (London Univ.). J. Atmos. Terrest. Phys., 29: 1037-44(Sept. 1967).

The results of calculations of Schumann Resonance frequencies and Q-factors and the propagation constant of the terrestrial waveguide at extremely low frequencies (elf) are reported. Calculations were made for ionosphere conductivity profiles derived by Pierce and Cole [J. Geophys. Res., 70: 2735 (1965)] and by Deeks. The results are sensibly identical to those obtained using the simple two-layer model derived previously by the author, and as such are compatible with experimental data obtained from studies of Schumann resonance and atmospherics. (auth) (UK)

5253 DIURNAL DISTRIBUTION OF SSCs OF DIFFERENT SIZES IN H IN THE ALIBAG MAGNETOGRAMS FOR THE PERIOD 1921 TO 1960. Sastri, N. S.; Jayakar, R. W. (Colaba Observatory, Bombay). J. Atmos. Terrest. Phys., 29: 1165-7 (Sept. 1967).

Diurnal distribution of frequency of occurrence at Alibag of SSCs of different sizes of the main impulse in 'H' is examined and is found to depend to a large measure on their sizes. The distribution curves for size-ranges $\leq 10\ \gamma$ and 11 to 30 γ show a general resemblance to the S_q(H) curve at Alibag. (auth) (UK)

5254 ATMOSPHERIC WINDS BETWEEN 100 AND 700 KM AND THEIR EFFECTS ON THE IONOSPHERE. Kohl, H. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.); King, J. W. J. Atmos. Terrest. Phys., 29: 1045-62(Sept. 1967).

The global wind system produced at different local times by pressure gradients in the upper atmosphere is calculated using data from Jacchia's model atmosphere. The horizontal wind velocities vary with height, and are of the order of 100 m sec^{-1} at about 300 km; they depend on ion drag, viscosity and Coriolis forces, but the major importance on ion drag as a force determining the form of the atmospheric wind system is demonstrated. The various limitations of, and approximations made in, the calculations are discussed in detail. The global atmospheric wind system produces important vertical ionospheric drifts, and it is suggested that these may readily explain many anomalous ionospheric observations, including the midday bite-out, some features of the maintenance of the night-time ionosphere, and the universal time effects observed in the high-latitude ionosphere. It is also suggested that various neutral atmosphere phenomena, such as the observed eastward rotation of the atmosphere, may also be a consequence of the wind system. (auth) (UK)

5255 RESULTS FROM AN RF CAPACITY PROBE EXPERIMENT IN THE AURORAL IONOSPHERE. Holt, O.; Lerfald, G. M. (Norwegian Defence Research Establishment, Kjeller). Radio Sci., 2: 1283-94(Nov. 1967).

A rocket-borne experiment, in which measurements of the rf capacity of two spherical probes of different size were taken at several frequencies, is described. The experiment was designed to measure electron density, and was performed during an auroral disturbance. Analysis shows the data agree up to 90 km with electron density measurements by a wave-propagation experiment. Above this height the probe data indicate the presence of field-aligned enhancements in the ionization. The characteristic "thickness" of these enhancements is ≈400 meters. The electron temperature could be estimated from the data, and values in excess of the neutral temperature were indicated. (auth)

5256 MULTIPLE SCATTERING IN A RANDOM CONTINUUM. deWolf, D. A. (RCA Labs., Princeton, N. J.). Radio Sci., 2: 1379-92(Nov. 1967).

The statistics of multiple-scattering contributions to the electric field received at a point beyond a layer containing a forward-scattering random dielectric continuum are investigated. Specific statistics such as first and second moments of the field are derived via high-frequency approximations in all terms of the Born series, thus circumventing controversial derivations from an approximated wave equation. The results and their range of validity are compared to those predicted by Rytov's approximation. (auth)

5257 NOMENCLATURE FOR OBLIQUE IONOSPHERIC SOUNDINGS AND RAY TRACING. Davies, Kenneth (Environmental Science Services Administration, Boulder, Colo.). Radio Sci., 2: 1395-6(Nov. 1967).

Recommendations of international working parties (at Lindau, Germany, and Leicester, England) concerning descriptive nomenclature and standard parameters for use in oblique ionospheric radio propagation are presented. The description of oblique ionograms involves the use of terms such as lowest observed frequency, maximum observed frequency, and junction frequency. Path structure is defined by reflections from ionosphere and ground starting at the transmitter. This method is extended to the case of backscatter. Finally, for intercomparison of magnetoionic ray-tracing programs, standard numbers are suggested for the Earth's radius, the free-space velocity, and the geomagnetic field. (auth)

5258 ON THE IMPORTANCE OF ELECTRIC FIELDS IN THE MAGNETOSPHERE AND INTERPLANETARY SPACE. Alfven, H. (Royal Inst. of Tech., Stockholm). Space Sci. Rev., 7: 140-8(Oct. 1967).

A survey is presented of current theories that describe the production and existence of electric fields in the magnetosphere and interplanetary space. Discussions are included on properties of the interplanetary medium, solar rotation, Sun's magnetic field, current system in the magnetosphere, and the border between interplanetary space and the magnetosphere. (J.H.M.)

5259 MAGNETIC STORM EFFECTS ASSOCIATED WITH THE TAIL OF THE MAGNETOSPHERE. Axford, W. I. (Cornell Univ., Ithaca, N. Y.). Space Sci. Rev., 7: 149-57(Oct. 1967).

Various aspects of the interaction of the solar wind with the magnetosphere are discussed. Consideration is also given to energy dissipation during magnetic storms and the conversion of magnetic energy in the tail of the magnetosphere. (J.H.M.)

5260 NEUTRAL POINTS ON THE BOUNDARY OF THE CLOSED MAGNETOSPHERE. Mead, Gilbert D. (Goddard Space Flight Center, Greenbelt, Md.). Space Sci. Rev., 7: 158-65(Oct. 1967).

Theoretical studies of a field-free plasma incident upon a magnetic dipole lead to a closed magnetosphere with two neutral points in the noon magnetic meridian, at a latitude of $\pm 70^\circ - 75^\circ$ and a geocentric distance of approximately 10 R_E. The position of the neutral points with respect to the dipole axis is not greatly affected by the angle of incidence of the solar wind. Although the field magnitude near the neutral points is only a fraction of the dipole field, the direction is seen to reverse on opposite sides of the neutral point. Near the boundary the field direction is parallel to the boundary and tends to point towards the neutral point in the Northern hemisphere. (auth)

5261 RECENT MEASUREMENTS OF THE MAGNETIC FIELD IN THE OUTER MAGNETOSPHERE AND BOUNDARY REGIONS. Heppner, J. P. (Goddard Space Flight Center, Greenbelt, Md.). Space Sci. Rev., 7: 166-90(Oct. 1967).

Magnetic-field measurements in the outer magnetosphere and boundary regions from the EGO spacecraft are presented, and the structure and directions of the interplanetary magnetic field are illustrated from IPM-1 measurements. Illustrations are also included of the geomagnetic cavity in the noon–midnight meridian plane and the location of the magnetosphere boundary from the noon hour back to the early morning hours. Shock front characteristics, the transition region, the magnetospheric boundary, long period magnetospheric field oscillations, the magnetospheric tail, and magnetospheric field behavior during auroral zone magnetic bays are discussed. (J.H.M.)

5262 DESIRABLE MAGNETIC-FIELD MEASUREMENTS IN THE HIGH-LATITUDE MAGNETOSPHERE. Bostrom, R. (Royal Inst. of Tech., Stockholm). Space Sci. Rev., 7: 191-7 (Oct. 1967).

Magnetic-field measurements and auroral current systems are discussed. Models of auroral current systems are shown, and information is included on how the auroral electrojet circuit is closed. (J.H.M.)

5263 COUPLING BETWEEN THE OUTER MAGNETOSPHERE AND THE HIGH-LATITUDE IONOSPHERE. Block, L. P. (Royal Inst. of Tech., Stockholm). Space Sci. Rev., 7: 198-210(Oct. 1967).

The coupling between the ionosphere and the outer magnetosphere depends on the topology of the geomagnetic field. Some aspects of the closed and open magnetospheric models are briefly discussed. The assumption that the geomagnetic field lines are equipotentials is critisized both on observational and on theoretical grounds. Measurements of H_α Doppler profiles, of precipitating particles above the ionosphere, and of charged particle densities in the magnetosphere indicate the existence of electric fields, $E_{||}$, parallel with the magnetic field. Two different models of $E_{||}$ are considered. Both models violate the condition of frozen-in magnetic fields. In one of them there are occasional transient electric field impulses along the field lines which cause precipitation splashes. The other model invokes electrostatic fields which vanish occasionally due to instabilities. This gives rise to precipitation splashes of about equal numbers of ions and electrons. The latter model seems to be favored by known satellite data concerning the pitch angle distributions of electrons above the ionosphere. It is suggested that electric fields in space should be measured by satellites and rockets. Expected values of the fields in different regions of space are given. (auth)

5264 DYNAMICAL MODEL OF AURORAL MORPHOLOGY. DeWitt, R. N. (Univ. of Alaska, College). Space Sci. Rev., 7: 211-27(Oct. 1967).

After an extensive study of individual auroral displays by means of photographs taken simultaneously by the I.G.Y. world-wide network of all-sky cameras, Akasofu was able to construct a model of global scale which describes the behavior of the aurora. A description of this model is presented. Discussions are included under the following topic areas: global distribution of auroras, the auroral substorm, relationship between the auroral substorm and the polar magnetic substorm, the auroral oval on the dayside, polar cap aurora, the transition zone, variations in position of the auroral oval, and the relationship of aurora morphology to the configuration of the magnetosphere. (J.H.M.)

5265 MEASUREMENT OF ELECTRIC FIELDS IN THE IONOSPHERE AND MAGNETOSPHERE. Boyd, R. L. F. (London Univ.). Space Sci. Rev., 7: 230-7(Oct. 1967).

Consideration is given to the problem of making electric-field measurements in the ionosphere and magnetosphere. Discussions are included on the magnitude of fields expected, the problem of plasma in electric-field measurements, and the use of ion motions. (J.H.M.)

5266 THEORY OF ELECTRIC FIELD MEASUREMENTS CONDUCTED IN THE MAGNETOSPHERE WITH ELECTRIC PROBES. Fahleson, U. (Royal Inst. of Tech., Stockholm). Space Sci. Rev., 7: 238-62(Oct. 1967).

Various methods for electric-field measurements in the magnetosphere are reviewed. Special consideration is given to successful field measurements with electric probes. Discussions are included on design criteria for electric probe systems, the theory of a double probe with a center electrode, possible errors, probe dimensions, and electric-field measurements along magnetic field lines. It is concluded that there should be no great difficulties in making rough measurements of electric fields in the ionosphere. (J.H.M.)

5267 RECENT RESULTS FROM SATELLITE MEASUREMENTS OF LOW-ENERGY PARTICLES PRECIPITATED AT HIGH LATITUDES. Evans, J. E.; Johnson, R. G.; Sharp, R. D.; Reagan, J. B. (Lockheed Palo Alto Research Lab., Calif.). Space Sci. Rev., 7: 263-77(Oct. 1967).

Low-energy particle data are presented from measurements

taken over the past few years at high latitudes and from low-altitude oriented polar-orbiting satellites for two days in May, 1963 and for five days in October and November of 1963. Consideration is given to low-energy proton measurements, proton precipitation patterns, total proton energy precipitated, low-energy electron precipitation patterns, electron-energy spectra, proton-energy spectra, and the ratio of precipitated proton energy to precipitated electron energy. (J.H.M.)

5268 ENERGETIC PARTICLE OBSERVATIONS FROM IMP-B SATELLITE. Rothwell, P. (Univ. of Southampton, Eng.). Space Sci. Rev., 7: 278-87(Oct. 1967).

Data are analyzed from the Berkeley energetic particle experiment on the IMP-B satellite, in which: (1) the position of the boundaries of the Van Allen trapping region and the distant radiation zone have been mapped as a function of radial distances from the earth, magnetic latitude, and local time; and (2) the sharp sporadic increases in 40-keV electrons beyond the boundary of the distant radiation zone on the dark side of the earth have been compared with ground magnetometer data. The satellite data were obtained by an electron detector sensitive to electrons of 40 keV only, and by an ion chamber sensitive to electrons with energies larger than approximately 1.5 MeV and protons with energies larger than approximately 20 MeV. (J.H.M.)

5269 PARTICLE MEASUREMENTS ON AN ESRO SATELLITE (NEUTRAL-1) IN A HIGHLY ECCENTRIC POLAR ORBIT. O'Brien, Brian J. (Rice Univ., Houston, Tex.). Space Sci. Rev., 7: 293-301(Oct. 1967).

A suggestion on how to improve particle measurements in unexplored regions of the magnetosphere by a high-altitude oriented high-inclination orbiting satellite is presented. It is concluded that a satellite such as the one suggested should be instrumented with magnetometers, plasma detectors, and detectors of energetic particles. (J.H.M.)

5270 U. S. STANDARD ATMOSPHERE SUPPLEMENTS, 1966. Prepared Under Sponsorship of Environmental Science Services Administration, National Aeronautics and Space Administration, and United States Air Force. 306p. $4.00, GPO.

Tables of typical winter and summer conditions for various latitudes are provided for the troposphere, stratosphere, and mesosphere. The models merge into three sets of boundary conditions at 120 kilometers in the lower thermosphere. Models starting from these boundary conditions then branch upward into atmospheric profiles which are related to the wide range of conditions in the heterosphere associated with varying solar activity, geomagnetic activity, and zenith angle of the Sun. (M.O.W.)

5271 IONOSPHERIC HEATING BY MAGNETIC CONJUGATE POINT PHOTOELECTRONS AS OBSERVED AT ARECIBO. Carlson, Herbert Christian, Jr. Ithaca, N. Y., Cornell Univ., 1966. 130p.

Thesis.

Incoherent backscatter measurements of ionospheric electron temperature made at the Arecibo Ionospheric Observatory are reported. Some of these observations are interpreted in terms of a streaming of photoelectrons from a sunlit magnetic conjugate ionosphere. Details of these observations are explained in terms of a semi-quantitative model for the heating mechanism. It is proposed that this streaming also accounts for certain "anomalous" features of ionospheric f_0F_2 variations: the "declination" dependence of the midlatitude f_0F_2 evening increase, the midlatitude winter solstice midnight maximum in f_0F_2, and coupling between conjugate ionospheric density variations particularly as noted in a solar eclipse. It is concluded that for midlatitudes at altitudes near and above 300 km, photoelectrons streaming from the sunlit conjugate ionosphere can provide substantial ionospheric heating effects. The theory relevant to the incoherent backscatter measurements is also briefly reviewed, and the Arecibo facility and equipment described. The methods of observation and data reduction are presented and uncertainties in the reduced data are estimated. (Disser. Abstr.)

5272 THE WIND SHEAR THEORY OF SPORADIC E. Cunnold, Derek Martin. Ithaca, N. Y., Cornell Univ., 1965. 163p.

Thesis.

The experimental observations of temperate latitude sporadic E and of winds and wind shears in the E region : e reviewed, and the evidence for the relationship between sporadic E and wind shears is briefly presented. The simple theory (i.e., singly ionized gas) of the production of sporadic-E layers by the wind shear mechanism is reviewed and extended. It is shown to be adequate to explain the correlation between the occurrence of sporadic E and the horizontal component of the Earth's magnetic field, and also predicts the existence of a narrow zone in the vicinity of the geomagnetic equator in which this type of sporadic E has a reduced intensity. It is emphasized that the interpretation of the experimental observations of the relationship between winds and sporadic-E layers should be made with care especially because of the ambiguity associated with constant horizontal electric fields. It is suggested that a better test of the theory would be to use a rocket-borne magnetometer. Solutions are given for a variety of wind profiles, and diffusion and temporal effects are briefly considered. The theory is extended to include the effect of a mixture of positive ions with differing recombination coefficients. It is shown that the ion with the smallest recombination coefficient determines the maximum density in a sporadic-E layer and that these ions will predominate in the layer. It is pointed out that this is another good test of the wind shear theory—to send a rocket containing an ion mass spectrometer through a sporadic-E layer. An important result of this many-ion analysis is that only one of the major species of the positive ions in the E region need have a recombination coefficient as low as 3×10^{-8} cm^3/sec. It is suggested that this ion should be NO^+ despite contradictory laboratory results. Meteoritic ions are considered because of their exceptionally small recombination coefficient and it is expected that they will have their most important effect at night when they form a larger percentage of the positive ion content of the E region. It is suggested that negative ions exist in the E region at night. Their effect upon the wind shear theory is examined and in particular an attempt is made to find out whether their presence allows a sporadic-E layer to form at the position from which positive ions diverge. Several approximations are made because of the additional computational complications introduced by the negative ions. It is established that layers may be simultaneously produced at the positions from which positive ions diverge and to which positive ions converge provided that the ion–ion recombination coefficient is sufficiently less than the electron–ion recombination coefficient. (Disser. Abstr.)

5273 IONOSPHERIC RADIO PROPAGATION. Davies, Kenneth. Dover Books on Engineering and Engineering Physics. New York, Dover Publications, Inc., 1966. 484p. $2.25.

Chapters are given on the following: (1) the Earth's atmosphere, geomagnetism, and the sun, (2) theory of wave propagation, (3) synoptic studies of the ionosphere, (4) oblique propagation, (5) signal strength, (6) ionospheric disturbances, (7) ionospheric propagation predictions, (8) scatter propagation on very high frequencies, and (9) propagation of low- and very-low-frequency waves. (M.O.W.)

5274 SIMULTANEOUS MEASUREMENTS OF ELECTRON CONTENT AND CHARGED PARTICLE PRECIPITATION IN A REGION OF AURORAL ACTIVITY. Bradbury, J. N. (Lockheed Palo Alto Research Lab., Calif.); Evans, J. E.; Joki, E. G.; Moe, C. R.; Hook, J. L. 23p. (CONF-670429-20). DTIE.

From 48th Annual Meeting of American Geophysical Union, Washington, D. C.

Simultaneous measurements of charged particle precipitation and ionospheric electron content were made as part of a coordinated auroral zone experiment utilizing a low altitude polar orbiting satellite, two ground stations, and an instrumented B-17 aircraft. The satellite was equipped with particle and optical detectors and a three-frequency radio beacon, and electron contents were obtained by means of differential Doppler techniques. For the case described the coordinated data were obtained in an aurorally active region throughout which the electron content exhibited several large peaks. Enhancements in the electron content were observed to correlate well with regions of increased particle fluxes, indicating, for this case, to what extent variations in the nighttime electron content below 200 km could be attributed to corpuscular radiation. Heights of regions of ionization deduced from the radio data agree well with those calculated on the basis of the particle flux parameters. (auth)

Low-Temperature Physics

Refer also to abstracts 4522, 4524, 4525, 4527, 5470, and 5703.

5275 (ISS–67/24) PERIODICITY IN THE TRANSITION TEMPERATURE OF HELIUM II IN A ROTATING ANNULUS. Tabet, E. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Sept. 7, 1967. 7p. Dep.

A simple treatment is given of the behavior of superfluid helium in a rotating annulus. In strict analogy with superconductors, a periodicity in the transition temperature with respect to the angular velocity results. (auth)

5276 s–d EXCHANGE INTERACTION IN A SUPERCONDUCTOR. Soda, Toshio; Matsuura, Tamifusa; Nagaoka, Yosuke

(Tokyo Univ. of Education. Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 38: 551-67(Sept. 1967).

The scattering of a quasiparticle in a superconductor due to a magnetic impurity is calculated by a perturbation method. It is shown that the ratio of the dominant contribution of the successive order of terms in the perturbation series is given at T = 0 by the ratio $2J\rho \log (2D/\Delta)$ where ρ is the density of state at the Fermi surface divided by the number of atoms in the superconductor, J is the magnitude of the s−d exchange interaction, 2D is the band width, and Δ is the energy gap. If this ratio is greater than one, the perturbation series does not converge. This is connected with the existence of a bound state attached to the impurity atom. Following Yosida's theory on the bound state due to the s−d interaction in a normal metal, we examine the possibility of a bound state in a superconductor. It is shown that, if the s−d interaction is antiferromagnetic and stronger than the pairing interaction, a bound state is formed around the impurity spin, and that, if it is weaker, an excited level appears in the energy gap irrespective of the sign of the interaction. The condition for the existence of the bound state is found to be the same as the condition for the divergence of the perturbation series mentioned above. The effect on the density of states of quasi particles at finite concentration of magnetic impurities is briefly discussed. (auth)

5277 SCATTERING OF LASER LIGHT IN SUPERFLUID HELIUM. Grimm, Hans; Dransfeld, Klaus (Technische Hochschule, Munich). Z. Naturforsch., 22a: 1629-30(Oct. 1967).

A measurement of light scattering in superfluid helium is given as a function of temperature with a relative error of less than 2%. This demonstrates that precise measurements of the light scattering in liquid helium are quite feasible in spite of the small scattering cross section. (M.O.W.)

5278 PHONON–QUASIPARTICLE INTERACTIONS IN DILUTE SOLUTIONS OF ^{3}He IN SUPERFLUID ^{4}He. I. PHONON THERMAL CONDUCTIVITY AND ULTRASONIC ATTENUATION. Baym, Gordon; Ebner, C. (Univ. of Illinois, Urbana). Phys. Rev., 164: 235-44(Dec. 5, 1967).

Expressing the interaction between long-wavelength phonons and ^{3}He quasi particles in dilute solutions of ^{3}He in ^{4}He entirely in terms of macroscopic observables, we calculate the attenuation of first sound due to the ^{3}He viscosity, and the rate of scattering of phonons from the ^{3}He. The results for the attenuation are in excellent agreement with recent experiments. In addition, we calculate the thermal conduction due to phonons for $T \lesssim 0.6$°K; the conductivity is limited at very low temperatures by ultrasonic attenuation, while at higher temperatures it is predominantly limited by elastic phonon−quasi particle scattering. (auth)

5279 MOLAR VOLUME, COEFFICIENT OF THERMAL EXPANSION, AND RELATED PROPERTIES OF LIQUID ^{4}He UNDER PRESSURE. Elwell, David L.; Meyer, Horst (Duke Univ., Durham, N. C.). Phys. Rev., 164: 245-55(Dec. 5, 1967).

From measurements of the dielectric constant, we have determined the molar volume of liquid ^{4}He along various isobars in the region 1.25 to 4.2°K and 0.5 to 28 atm. Tables of molar volume, thermal expansion coefficient α_P, entropy of compression, and isobaric change in the isothermal compressibility are presented for this region. Values of T_λ, P_λ, and V_λ are presented. Particular emphasis was put on the form of the expansion coefficient near the λ transition. We have found that the α_P singularity is logarithmic over the range of 2×10^{-5} to 10^{-2} °K displacement from the transition, and from the data that lead to this conclusion, we have been able to calculate various other properties of the fluid near the transition. These results are compared with those of other experiments wherever possible. (auth)

5280 VARIATIONAL CALCULATIONS ON LIQUID ^{4}He AND ^{3}He. Massey, Walter E. (Argonne National Lab., Ill.); Woo, Chia-wei. Phys. Rev., 164: 256-9(Dec. 5, 1967).

Assuming a Lennard−Jones 6-12 potential with the de Boer−Michels parameters, the ground-state energies of systems of liquid ^{4}He and ^{3}He are calculated by a variational procedure in conjunction with the method of correlated basis functions. Comparisons are made with the results of McMillan and of Schiff and Verlet. These comparisons shed some light on the validity and adequacy of the Jastrow- and Jastrow−Slater-type wave functions in the description of helium liquids. (auth)

5281 ORDER OF THE ^{4}He II–^{4}He I TRANSITION UNDER ROTATION. Ahlers, Guenter (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 164: 259-62(Dec. 5, 1967).

Purely thermodynamic considerations show that the volume discontinuity at the ^{4}He II → ^{4}He I transition under rotation reported by Andronikashvili and Tsakadze cannot correspond to a transition between thermodynamic equilibrium states if $(\partial P/\partial T_\lambda)_\omega < 0$. Experimental results are presented which show that the transition $|\Delta H| \leq 6 \times 10^{-4}$ J/mole and $|\Delta V| \leq 3 \times 10^{-5}$ cc/mole at $\omega = 30$ sec^{-1}. Thus, within these limits, the transition is of higher than first order. (auth)

5282 SUPERFLUID FLOW TRANSITIONS IN ROTATING NARROW ANNULI. Bendt, Philip J. (Univ. of Oregon, Eugene). Phys. Rev., 164: 262-7(Dec. 5, 1967).

The attenuation of second sound has been used to observe helium-II flow transitions in five annuli in solid-body rotation at 1.40°K. The annuli were 0.6 to 1.9 mm wide, and approximately 15 mm in radius. The onset of attenuation of second sound at the angular velocity Ω_0 predicted by Fetter for the creation of a single row of vortex lines established that liquid helium in rotation is able to attain the state of lowest free energy. The onset of attenuation of the second harmonic, which has a velocity node at the middle of an annulus, showed that vortices can be detected away from the median radius at approximately 1.9 Ω_0. In the range $0.65 < \Omega < 0.95$ rad/sec, a critical velocity Ω_3 was observed through two effects: First, in annuli in which $\Omega_0 < \Omega_3$, it was usually necessary to rotate faster than Ω_3 before the helium would display second-sound attenuation at Ω_0. Second, in the narrowest annulus, where $\Omega_3 < \Omega_0$, strong attenuation occurred at Ω_3 even though the equilibrium state is vortex-free irrotational flow. The transition at Ω_3 is identified with the creation of long-lived vorticity in the helium. (auth)

5283 QUANTIZED CIRCULATION AND HEAT TORQUES. Penney, R.; Overhauser, A. W. (Ford Motor Co., Dearborn, Mich.). Phys. Rev., 164: 268-9(Dec. 5, 1967).

It is shown that there will exist a torque on a cylindrically symmetric, uniformly heated body immersed in liquid helium if and only if there exists trapped circulation about the body. The resultant torque will be quantized if the circulation is. For a heat input of 10 mW, a single quantum of circulation would yield a torque of 5×10^{-7} dyne cm, which is of reasonable magnitude. (auth)

5284 OPTICAL CHARACTERISTICS OF SUPERCONDUCTING MAGNETIC LENSES WITH VERY HIGH FIELD. APPLICATION TO VERY HIGH VOLTAGE ELECTRON MICROSCOPY. Genotel, Denis; Laberrigue, Andre; Levinson, Paul; Severin, Claude (College de France, Paris). Compt. Rend., Ser. A and B, 265: 226-9(July 24, 1967). (In French).

Magnetic lenses with short focal distances were obtained by utilizing the properties of superconducting alloys in which very high current densities are obtainable. For 5,000 keV the focal distance can be reduced to 6.1 mm. (tr-auth)

5285 BAND STRUCTURE AND SUPERCONDUCTIVITY OF A_3B-TYPE INTERMETALLIC COMPOUNDS WITH β-W STRUCTURE. Nemnonov, S. A.; Kurmaev, E. Z. (Inst. of the Physics of Metals, Sverdlovsk, USSR). Phys. Status Solidi, 24: K43-7 (Nov. 1, 1967).

Results are discussed of x-ray studies of the $K\beta_5$-emission bands of V and Cr in V_3Si and Cr_3Si and the x-ray K-absorption spectrum of Cr in Cr_3Si. The band structure as found from the studies is discussed. The absence of superconductivity in Cr_3Si is due to the low density of states at the Fermi level. (D.L.C.)

5286 ELECTROSTATIC EFFECT AND SUPERCONDUCTIVITY IN TINY SAMPLES. Markowitz, David (Univ. of Connecticut, Storrs). Physics, 3: 199-219(Aug. 1967).

It is suggested that the Anderson phase-number relations (developed for the Josephson effect) should be applied to a superconductor in equilibrium. This adds to the BCS postulates a further one: there exists an intrinsic phase spread across a suitable domain in a sample and a corresponding uncertainty in the number of electrons in that domain. The new Hamiltonian contains a Coulomb repulsion term, and the new wave function contains unpaired occupied states even in the ground state. Minimization of the energy shows that the size of the domain within which the phase spread exists is the size of the sample. Detailed numerical solution finds that only for beads of 100 to 500 Å will the results differ significantly from the BCS or bulk case. Excited states and thermal properties are solved for in detail and other properties are discussed. Predictions are a smaller gap and a lower critical temperature than in bulk, a first-order transition to the normal state, and an effective density of states for single-particle transitions at very low temperatures which exceeds that in the normal state. It is well known that the samples in Knight shift experiments are of the size necessary to test these predictions; however, the effects predicted here are not found. It is suggested that those samples are not in electrical isolation, in violation of a condition critical for the detection of the electrostatic effect. (auth)

5287 MICROSTRUCTURE ASSOCIATED WITH THE PEAK EFFECT (MAXIMUM IN CRITICAL CURRENT DENSITY) IN

SUPERCONDUCTING NIOBIUM. Mater. Sci. Eng., 1: 360-4 (Mar. 1967).

A study is made of the precipitate and dislocation structures associated with the peak effect in Nb. Peak first occurs at 1400 C.; maximum height of peak occurs at 1500 C. Electron transmission microstructures of Nb, after annealing at 1200, 1300, 1400, and 1500 C., are shown. Peak effect occurs when dislocation tangles do not exist and the number of dislocations and precipitates is significantly reduced. Maximum in peak occurred under the following conditions: no evidence of precipitates; all dislocations existed in sub-boundaries; and the number of such sub-boundaries was a maximum. An additional experiment confirms that the peak effect occurs for a particular dislocation–impurity atom structure, which is not changed by a subsequent 1200 C. anneal. (Rev. Met. Lit.)

5288 NANOHM RESISTANCE JOINTS TO ALUMINUM. Atherton, David (Ferranti–Packard Electric Ltd., Toronto). Rev. Sci. Instrum., 38: 1805(Dec. 1967).

Interest in the potential use of aluminum for stabilized superconductors has led to an investigation into the production of low-resistance joints to aluminum. Joints with contact resistances of less than a nanohm have been made by fluxless ultrasonic soldering. These were measured by Atherton's technique for low joint resistances in which the joints are included in a superconducting loop of known inductance, which is cooled below its transition temperature in close proximity to a permanent magnet. The magnet is then removed and the decay time constant of the induced semipersistent current is determined by field-decay observations using a Hall probe. (auth)

5289 IRON MAGNET WITH SUPERCONDUCTING COIL. Fast, R. W.; del Castillo, G.; Winter, W. R. (Univ. of Wisconsin, Madison). Rev. Sci. Instrum., 38: 1789-91(Dec. 1967).

A model magnet has been constructed to study the behavior of a large superconducting coil on an iron yoke at room temperature. The coil, wound with niobium stannide ribbon, has an average diameter of 40 cm, a maximum excitation of 5×10^5 ampere-turns, and a stored energy of 85 kJ. The superconductor carries the same current, 120 A, on the pole and yoke as it did when removed from all iron. Nylon spacers served as compression members of low thermal conductivity to support the 18,000 kg magnetic force. (auth)

5290 MODIFICATION OF THE UPPER CRITICAL FIELD IN A TWO-BAND SUPERCONDUCTOR. Wong, Victor K.; Sung, C. C. (Ohio State Univ., Columbus). Phys. Rev. Lett., 19: 1236-9(Nov. 20, 1967).

The upper critical field H_{c2} for a type-II two-band superconductor is investigated in the pure limit. Near T_c, H_{c2} is dominated by the s band, whereas the thermodynamic properties are determined by the d band. A modification to the Gor'kov theory is found for the ratio of $K_1(T)$ at $T = 0$ and $T = T_c$. This result may explain the discrepancy between the one-band theory and experimental data. (auth)

5291 THERMODYNAMIC AND ELECTROMAGNETIC PROPERTIES OF SUPERCONDUCTORS WITH NONMAGNETIC TRANSITION-ELEMENT IMPURITIES. Takanaka, Kenji; Nagashima, Tomitaro (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto), 38: 291-304(Aug. 1967).

Critical magnetic field and specific heat at low temperatures and near the transition temperature T_c are calculated for superconductors containing impurities and localized electrons. Near zero temperature the thermodynamical quantities are largely affected by the Coulomb correlation between localized electrons. On the other hand, the Coulomb correlation does not play an essential role near T_c. The BCS relations for various quantities remain valid if the change of state density due to the presence of the s–d admixture is taken into account. The effect of anisotropy is also briefly sketched and it is shown that the BCS relations do not remain valid if the anisotropy is taken into account. Lastly, the penetration depth is discussed. (auth)

5292 MAGNETIC FIELD SWEEP FOR SUPERCONDUCTING MAGNETS. Vanderkooy, J.; Moss, J. S.; Datars, W. R. (McMaster Univ., Hamilton, Ont.). J. Sci. Instrum., 44: 949-50 (Nov. 1967).

A power supply is described which allows the field of a solenoidal superconducting magnet to be swept linearly with time to a high degree of accuracy. A linear sweep rate is btained by maintaining a constant voltage across a coil that measures the rate of change of magnetic field. (auth)

5293 EXPERIMENTS ON THE DISTRIBUTION OF A TRANSPORT CURRENT IN SHEETS OF SUPERCONDUCTORS OF THE SECOND KIND. Staas, F. A.; Niessen, A. K.; Druyvesteyn, W. F. Philips Res. Rep., 22: 445-62(Oct. 1967).

Experiments are reported on the distribution of a transport current in sheets of a Nb–50 at. % Ta alloy, as well as in cold-rolled and annealed foils, and also in cold-rolled foils of a Pb–30 at. % In alloy, and of a Nb–25 at. % Zr alloy. The experiments are interpreted qualitatively. In small magnetic fields the transport current is carried by the regions near the edges of the sample to a somewhat greater extent than it is in larger fields. In certain field regions an asymmetrical current distribution is observed due to the magnetic field caused by the transport current. Related to this effect on a sample which was copper-plated on one side only, a longitudinal voltage is found which depends on the polarities of the transport current and magnetic field. In the specimens showing the "dip effect," an anomalous behavior in the current distribution occurs at the same magnetic fields where the minimum in the R/R_N vs H_0 curve is found. (auth)

5294 HIGH-RESOLUTION BITTER PATTERNS ON SUPERCONDUCTORS. Sarma, N. V.; Moon, J. R. (International Research and Development Co. Ltd., Newcastle-Upon-Tyne, Eng.). Phil. Mag., 16: 433-45(Sept. 1967).

A new technique is described for replicating the distribution of magnetic flux in superconductors. The technique involves the deposition of fine ferromagnetic powders, formed by evaporation in a poor vacuum, on to the surface of the superconductor. The patterns formed by the powder replicate the distribution of magnetic flux with a resolution of the order of 400 Å. Macroscopically the patterns are consistent with predictions arising from the Bean model, and with the recent experimental data obtained by Cline, Rose and Wulff using a magnetoresistance probe. The microscopic patterns on a cold-worked specimen of niobium–25% zirconium exhibit a cellular configuration similar in size and shape to the dislocation configuration of the specimen. On an annealed specimen of the same material the microscopic pattern replicates the distribution of a second-phase precipitate and the grain structure of the specimen, while the cellular configuration is absent. (auth) (UK)

5295 FLUX PENETRATION AND AC LOSSES IN SUPERCONDUCTING NIOBIUM. Easson, R. M.; Hlawiczka, P. (Univ. of Glasgow). Brit. J. Appl. Phys., 18: 1237-49(Sept. 1967).

Measurements of flux penetration and dissipation at 50 cps were made on niobium samples, shaped to approach closely the case of slab geometry, with a tangential applied field. When corrected for end effects the measured quantities were independent of sample thickness, which varied from 0.125 to 0.004 in. Comparison of the experimental results with the Bean–London model yields little quantitative agreement. (auth)

5296 IRREVERSIBLE MAGNETIZATION IN SUPERCONDUCTORS. Birchak, J. R. (Rice Univ., Houston, Tex.). J. Phys. Chem. Solids, 28: 917-25(June 1967).

The temperature and field dependence of hysteresis for tin, lead, and niobium is described by attributing it to three different sources. First, there is supercooling, which was observed only for tin and lead and sometimes disappeared at certain temperatures. Second, various inhomogeneities distributed throughout the material seem responsible for trapped flux that had the same temperature dependences as J_c for tin and lead and that had the behavior expected from the pinning model for niobium. Third, the very small trapping that occurred when the external field was cycled between $+H_{max}$ and $-H_{max}$, with H_{max} so small that the sample never entered the intermediate or mixed state, is attributed to microscopic irregularities. (auth)

5297 p-WAVE SCATTERING EFFECTS ON ULTRASONIC ATTENUATION IN DIRTY SUPERCONDUCTORS. Houghton, A.; McLean, F. B. (Brown Univ., Providence). J. Phys. Chem. Solids, 28: 1721-3(Sept. 1967).

The coefficients of ultrasonic absorption in dirty superconductors for small energy gap are calculated taking into consideration both s-wave and p-wave scattering of the electrons by impurities. (auth)

5298 EQUILIBRIUM PROPERTIES OF BOSON SYSTEMS AT LOW TEMPERATURES. Wong, Victor Kenneth. Berkeley, Calif., Univ. of California, 1966. 284p.

Thesis.

A study of the equilibrium properties of boson systems at low temperatures with particular emphasis on the Bose–Einstein transition and restricted geometry is undertaken both from the microscopic and the macroscopic viewpoints. Use of the Green's function formulation enables the systematic study of essentially all microscopic models in the literature. In particular the zeroth-order approximation is the ideal Bose gas, which is applied to the problem of restricted geometry. The first-order approximations include the Bogolyubov/ideal, Hartree, Bogolyubov/Hartree, Hartree–Fock, and Bogolyubov/Hartree–Fock approximations. With the sole exception of the Hartree, the first-order approxima-

tions display a double-valued behavior in the number density and other thermodynamic functions. Application to restricted geometry results in the same problem as with the ideal Bose gas, namely that the macroscopic occupation, i.e., the Bose–Einstein condensation, does not strictly appear in restricted geometry. The second-order approximations include the Belyaev/Hartree–Fock, Born-collision, Bogolyubov/Born-collision, Belyaev/Born-collision approximations. The Born-collision approximation is concentrated on, showing that it gives a logarithmic singularity to the specific heat in the very dense state limit. The Born-collision approximation is applied to restricted geometries by a variational technique. From the macroscopic viewpoint, we show that the Ginzburg–Pitaevskii theory can yield only second-order transitions in film geometries as well as in bulk systems. Based on symmetry considerations, we propose a new, modified theory in which the order function is identified with the "anomalous" self-energy, which we motivate by a microscopic argument. The new theory is shown to agree with the experimental behavior of the superfluid mass density and the jump in the specific heat, to satisfy the exponent scaling laws, to give a third-order transition in film while giving a second-order in bulk, and to yield shifts in the transition temperature in agreement with experimental observations. (Disser. Abstr.)

5299 TRANSLATIONAL OSCILLATION OF CYLINDERS AT HIGH AMPLITUDES IN LIQUID HELIUM II. Thibodeaux, Devron Paul. Baton Rouge, Louisiana State Univ., 1967. 115p.

Thesis.

Measurements have been made of the period and the logarithmic decrement of pairs of cylinders oscillating at high amplitude in liquid helium II between 2.17 and 1.2°K. Both of these quantities are found to be constant for amplitudes less than a critical amplitude A_c which can be expressed by $A_c = 1.12\ (a^2 \tau \nu_{eff})^{\frac{1}{3}}$, where a is the cylinder radius, τ is the period of oscillation, and ν_{eff} is an effective kinematic viscosity which is set equal to the kinematic viscosity of the normal fluid (ν_n) close to the lambda point, but is a very weak function of temperature. At amplitudes greater than A_c there is an increase in the log decrement and a decrease in the period which correspond to changes in the added mass coefficient k and the damping coefficient k'. These changes are related to the relative amplitude R by $\Delta k' = .17R^2$ for $R > 1$ and $\Delta k = -.077R^3$ for $1 < R < 2.2$. Comparison with the results of similar experiments in ordinary liquids shows that at temperatures close to the lambda point ($T > 2.1$°K), the changes in k and k' are due to the normal fluid only. At lower temperatures ($T \sim 1.3$°K), a significant portion of the superfluid takes part with the normal fluid in producing these changes. The interaction between the two fluids is characterized by the weak temperature dependence of ν_{eff} and by an effective density ρ_{eff} introduced to make $\Delta k'$ and Δk independent of temperature. This ρ_{eff} is found to be independent of amplitude, which shows that the fraction of superfluid involved is not dependent on velocity; however, the fraction of superfluid which contributes to ρ_{eff} is found to be inversely proportional to the period τ. An attempt is made to show how some of these results may be due to the creation of quantized vortex lines in the superfluid. (Disser. Abstr.)

5300 LOW-ENERGY EXCITATIONS IN LIQUID HELIUM. Skiff, Peter Duane. Baton Rouge, Louisiana State Univ., 1967. 79p.

Thesis.

A variational approximation method described by Valatin and Butler is used as a basis for describing the low-temperature behavior of liquid helium. It is assumed that the Fourier transform of the interaction potential of the He atoms has a Gaussian form, specified by two parameters. For a particular choice of these two parameters, for which the corresponding Gaussian transform is in good qualitative agreement with a transform obtained from gas data, the ground state expectation value of the number of He atoms with zero momentum is calculated to be 8%, in agreement with the experimental value deduced by Penrose and Onsager. For the same choice of parameters, a curve (called the dispersion curve) is calculated for the energy versus momentum relation for the elementary excitations in the liquid. The resulting dispersion curve correctly passes through the origin linearly with a slope equal to the experimental value of the speed of sound in the liquid. However, this dispersion curve diverges increasingly from the experimental results of Henshaw and Woods as the momentum (and energy) of the excitations is increased from zero; and, in particular no minimum occurs. This result is interpreted as probably due to an inadequacy of the weak interaction assumption implied by the method of Valatin and Butler. (Disser. Abstr.)

Plasma and Thermonuclear Physics

Refer also to abstract 5430.

5301 (AED-C-03-13) DOCUMENTATION OF PLASMA PHYSICS. PART 1. EXPERIMENTAL PLASMA PHYSICS THEORETICAL PLASMA PHYSICS. BIBLIOGRAPHY, AUTHOR INDEX, SUBJECT INDEX. VOLUME 2. Hilsenbeck, D. (Zentralinstitut fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Oct. 1967. 166p. Dep.

A listing is presented of 315 papers on various aspects of plasma physics. Subject and author indexes are included. (M.O.W.)

5302 (JUL-494-PP) ARBEITSBERICHTE DER THEORETISCHEN UND EXPERIMENTELLEN GRUPPEN FUER DAS JAHR 1966. (Progress Report of the Theoretical and Experimental Groups for the Year 1966). Vogelbruch, K. (comp.) (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). June 1967. 78p. (In German). Dep.

The theoretical studies continued the investigation of the properties of plasmas under conditions as are necessary for the obtainment of thermonuclear reactions or for the simulation of processes in the magnetosphere. Studies on the structure of nonlinear waves in plasma, the processing of questions on the kinetic theory of electromagnetic radiation, the investigation of boundary layers between collision-free plasma and magnetic fields, and investigations on the adiabatic invariance of charged particles were continued. In experiments with 600-kJ theta pinch it was shown that it gave suitable initial conditions in which a considerable antiparallel magnetic field was confined in the plasma. It is difficult to decide whether observed inhomogeneities are an indication of initial instabilities; they can arise from effects of the coil ends or from certain unproportionalities of the compression coil. A coil with improved symmetry and with a larger number of uniformly distributed narrow windows was prepared. A crowbar system, which lengthens the observation time, was introduced; the feed energy was simultaneously increased to 1.2 Mjoule. In the cusp experiment an investigation of the preheated plasma permitted a suitable selection of the initial conditions for the principal discharge. Compressed plasma with sufficient temperatures ($T_e \approx T_i \approx 150$ eV), densities ($n_e \approx 10^{17}$ cm^{-3}), and volume ($V \approx 15$ cm^3) can be produced. Under these conditions the penetration time of the magnetic field in the plasma, as the classical theory yields, is sufficiently large; the investigation of the actual cusp loss was possible. The 40-kV experiment on fast magnetic compression, which yields steep field rise, works with good results. A parameter study at various initial conditions was carried out. As expected, the temperatures obtained were much higher than in the earlier smaller theta-pinch experiments. The development and improvement of methods for the measurement of electron temperatures (especially in the x-ray region) was facilitated. A comparison of the continuum intensity emitted by a theta-pinch plasma in the visible region with the theoretically predicted values show deviations which are larger than the measurement errors to be expected. The true origin of these deviations was investigated theoretically and experimentally. The experimental studies of the structure of collision waves in collision-free plasma were made in order to obtain a survey on the macroscopic phenomena forms of the different collision wave types in the case $\beta_0 = 8\pi kT_0/B_0^2 \ll 1$ and $\Theta \ll 1$; Θ is the angle between wave front and the direction of the initial magnetic field. At suitably small densities and Mach numbers, compression waves, dependent on the angle Θ, in which damped wave trains occur as forerunner and as follower, can be detected. At higher Mach numbers the pattern of the magnetic fields in the collision wave front is monotonous, as is expected in "turbulent" collision waves. From the density of the collision wave front, the effective conductivity was shown as about $^1/_{100}$ of the point conductivity. The planning of a traveling-wave accelerator for the production of plasma pulses of long duration (up to 20 msec) was concluded. A new accelerator was developed which gives plasma pulses with an energy of 10 keV. The high-voltage circuit for the acceleration (100 kV) was finished. A 1-m lattice spectrograph with striated light incidence and incident angle entering continuously from 80 to 89° was tested and used for the observation of spectral lines and spectral continua of the radiation of a vacuum slide spark. The fast television camera was introduced to numerous experiments for the measurement of the light density profiles. In the oscillography of the electric signals of a single image line, the signal amplitudes given is almost proportional to the corresponding light intensity. The simultaneous registration of a number of profiles of various image sites is possible. A Michelson interferometer with a light path approximately 3-m long in the plasma was used for the investigation of the preheating phase on the 600-kJ theta-pinch experiment. The end-on measured radial density distributions were compared with the values which, side-on, could be maintained by means of another optical method. The 2-mm microwave interferometer was tested on the collision wave experiment, in which a dielectric antenna of high space resolution was used.

Experiments on diffusion of plasma in neutral or weakly ionized gases were begun. They show that essentially the ambipolar diffusion is determinative for the observed development of the density profile. The ionization in strongly inductive magnetic fields was investigated as a conclusion to the measurement of the ionization ratio of hydrogen in electric ring fields. Such ratios are important in the ignition of theta-pinch discharges. The impedance of the coil was measured on the stationary ring discharge as a function of the inducing magnetic field. A simple functional relation was obtained which was established by the measured plasma properties. The principal activity of the technological group was connected with the planning and preparation of the reconstruction and disassembly of the 600-kJ high-current installation. Work on the pressure spark gap for high voltages up to 85 kV was extended with the result that the parallel wiring of many spark gaps is possible without decoupling conduction. (tr-auth)

5303 (NP-17128) ANNUAL PROGRESS REPORT [ON AEROSPACE STUDIES], 1967. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Oct. 1967. 129p.

Summaries of research are presented for the following: (1) mechanics of rarefied gases, (2) plasma dynamics, (3) hypervelocity flows, (4) energy conversion, (5) aerodynamic noise, (6) subsonic aerodynamics, (7) aerospace flight dynamics, (8) materials science and structures, (9) upper atmospheric research, (10) molecular beams and surface interactions, (11) high temperature gas dynamics and gas physics, and (12) industrial and architectural aerodynamics. (M.O.W.)

5304 THEORETICAL METHODS IN PLASMA PHYSICS. Van Kampen, N. G.; Felderhof, B. U. New York, John Wiley and Sons, Inc., 1967. 221p. $9.50.

The main topics discussed are: MHD equations, waves in magnetohydrodynamics, theory of MHD stability, statistical mechanics of a hot ionized gas, many-component theory, waves in cold plasmas, Vlasov plasmas, waves propagating along a magnetic field; micro-instabilities, and collisions in a hot electron gas. (M.O.W.)

5305 PLASMAS IN SPACE AND IN THE LABORATORY. Proceedings of the ESRIN Study Group, Frascati (Rome), May 9–June 3, 1966. Paris, European Space Research Organization, 1967. 563p. (CONF-660572). DTIE.

Thirty-two papers or their abstracts are included. (M.O.W.)

Confinement and Heating of Plasma

Refer also to abstract 5809.

5306 (COO-1233-59) [PLASMA PHYSICS]. Technical Progress Report, February 1, 1967–January 31, 1968. (Wisconsin Univ., Madison. Dept. of Physics). Nov. 1, 1967. Contracts AT(1233); AT(1726). 11p. Dep. CFSTI.

Research progress is discussed for the following areas: (1) continuing studies of plasmas contained in the toroidal octupole, (2) studies with gun injection into a linear quadrupole, (3) design studies of new multipole with free current-carrying conductors, (4) microwave diagnostics, (5) theoretical studies, and (6) cyclotron wave experiments. (M.O.W.)

5307 (IPP-6/61) ON DIFFUSION IN THE GARCHING OCTOPOLE DEVICE. Grawe, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Oct. 1967. 31p. Dep.

Previous papers on the octopole experiments treated the various loss mechanisms in the octopole device as independent of each other. In addition to diffusion across the magnetic field the loss flux along $\underline{B}$ to the supports of the ring conductors generating the field is important. In this paper these two loss mechanisms are taken into account simultaneously. Smearing out the loss flux along $\underline{B}$ around the machine one gets a simple differential equation for this loss, which is solved numerically together with a diffusion equation. Postulating Fick's law describing the diffusion the measured density profile was approximated by varying the diffusion coefficient. The best approximating coefficient is between resistive and Bohm diffusion but tends more to Bohm diffusion. Owing to the large ion gyroradii in the inner part of the machine, ion–ion collisions are also considered. The diffusion equation obtained from this mechanism describes the measured profile very well, but does not lead to a unique relation between the adjusted flux from the particle source and the peak particle density for the operating regime. (auth)

5308 (UCID-15241) PRELIMINARY INVESTIGATION OF THE PROPERTIES OF A SCALED-UP ASTRON. Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 30, 1967. Contract W-7405-eng-48. 21p. Dep. CFSTI.

The magnetic field pattern of a thick E layer and Bohm confinement time in this pattern are described. Plasma scaling laws, selection of the momentum of the E-layer particles for optimum plasma parameters, and calculations of the tolerable confinement time in comparison to Bohm confinement time are discussed. (M.O.W.)

5309 (NP-tr-1601) BREAKUP OF MAGNETIC SURFACES DUE TO MAGNETIC FIELD PERTURBATIONS. Zaslavskii, G. M.; Sagdeev, R. Z.; Filonenko, N. N. ([Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki]). Translated for Culham Lab., Abingdon, Eng., from pp 1-32 of Preprint No. 74. 26p. (CTO-422). Dep. CFSTI. UK. JCL $2.60 fs, $0.98 mf.

The work reported earlier is extended with the object of throwing light on questions relating to the condition permitting the existence of magnetic surfaces in stellarator-type closed systems. The unperturbed magnetic field geometry is set up by a straight helical field. The exact equations of motion of the magnetic field lines are presented in Hamiltonian form and action-angle variables are introduced. The effect on the field configuration is investigated of a perturbation which is periodic along the coordinate parallel to the torus axis. It is shown that for a perturbation exceeding some critical value, the motion of field lines sufficiently far away from the torus axis is analogous to a Brownian motion, and leads to a breakup of the magnetic surfaces. The conditions for the random instability of the magnetic field lines are obtained in explicit form, and an estimate is given of the diffusion coefficient of a field line out of the volume. The toroidicity of the field geometry is considered as a second type of perturbation. Regardless of the value of this correction, there is a random breakup of the magnetic surfaces close to the separatrix of the unperturbed magnetic field; this leads to an effective decrease of the region bounded by the separatrix of the perturbed field. The size of this region is estimated. (auth)

5310 EXPERIMENT OF CHARGE EXCHANGE LOSS OF PLASMA CONFINED BY MIRROR MAGNETIC FIELD. Mori, Ichiro; Suita, Tokuo. (Osaka Univ.). Denki Gakkai Zasshi, 87-4: No. 943, 729-36(Apr. 1967). (In Japanese).

An experiment was made on the loss in the relatively low-energy region, i.e., in the region where the charge exchange becomes important. The results were compared with the calculated ones in the case of the confinement by a mirror magnetic field in the presence of the remaining gas. By the calculation, it is shown that the 23-keV H_2^+ ions injected are caught in a mirror field for ~1 μs and subsequently lost by impinging upon the position of injection. The fast protons, produced by dissociation of H_2^+ ions, on the other hand, travel back and forth ~90 times through the mirror field, during which period most are lost by charge-exchange collisions with the life of about 37 μs. This is concluded from the exponential reduction of the density, obtained by the experiment. In the low-temperature plasma, the temperature of the electrons is raised about 6 eV at the time fast ions are caught. This is thought as due to the instability of the two fluids, caused by the passage of a fast ion beam through the plasma. The ratio of the flow out from the mirror field was obtained as 0.6. (NSA of Japan)

5311 STABLE CLOSED PLASMA SYSTEMS WITH CIRCULAR MAGNETIC SURFACES. Kosachev, V. V.; Trubnikov, B. A. Zh. Tekh. Fiz., 37: 1213-18(July 1967). (In Russian).

Solov'ev and Shafronov (STI-PUB-III(pp. 169–90)) have shown that in a closed magnetic plasma containment system having the topology of a torus and a constant magnetic field strength on the axis one can achieve stability (i.e., a negative second derivative of the volume within a magnetic surface with respect to the longitudinal magnetic flux enclosed by that surface) only with the aid of auxiliary helical stabilizing fields that represent the second and third harmonics of the main field and result in magnetic surfaces near the axis that have elliptical sections. In the present paper it is shown that by relaxing the condition that the magnetic field strength be constant on the axis one can achieve stability without the use of the auxiliary helical stabilizing fields and that the paraxial magnetic surfaces of such a stable system can have circular cross sections. The axis of such a stable system must have a nonvanishing torsion. A system whose axis is a regular helix is discussed in detail; although this system is open, the results obtained for it can be applied with little change to a closed system whose axis is a regular "helix" wound on the surface of a torus. Stability and confinement criteria are derived and numerical relaxations between the important design parameters are presented in a small table. (ATD)

5312 DEVICE FOR CONTAINMENT OF A HIGH TEMPERATURE PLASMA. Matsuda, Jinsaku (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-9746. May 25, 1966. Filed Apr. 12, 1965.

The device consists of the following: the discharge tube wound with a plasma-containment coil; a condenser charged by a dc source for the plasma-containment coil; a three-point gap device,

having the 1st, 2nd, and 3rd electrodes, which forms the electric circuit for discharging the condenser through the plasma-containment coil; a condenser between the 1st and the 2nd electrodes for the flash discharge in the three-point gap device; an auxiliary coil connected in series to the plasma-containment coil condenser; and the discharge-gap devices for short circuits, connected to the plasma-containment coil. The 3rd electrode is actuated for a flash discharge to occur in the three-point discharge gap device, and then the condenser is discharged through the two coils. When the electric current in the plasma-containment coil becomes a maximum, the gap devices (connected to this coil) are actuated to short circuit the plasma-containment coil. (NSA of Japan)

Diagnostics of Plasma

Refer also to abstracts 4526 and 5242.

5313 APPROXIMATION METHOD FOR CALCULATING ELECTRON CONCENTRATION IN THE TURBULENT BOUNDARY LAYER OF A WEAKLY IONIZED PLASMA. Motulevich, V. P. (Power Engineering Inst., Moscow). Teplofiz. Vys. Temp., 5: 458-63(May-June 1967). (In Russian).

A method is presented for calculating electron concentration in a turbulent boundary layer when a substance with low ionization potential is the sole source of electrons and is supplied from the direction of the circumfluent surface, due to its disintegration, or through porous elements. This problem is solved in conformity to plane and axisymmetric bodies. The intensity of substance supply is assumed sufficiently small as to have no effect on the thermo- and gasdynamic characteristics of the boundary layer. The plasma is assumed to be in either an equilibrium or congealed state. (ATD)

5314 USE OF LASER INTERFEROMETERS FOR DETERMINING ELECTRON CONCENTRATION IN PLASMA JETS. Ovsyannikov, A. A.; Polak, L. S.; Rovinskii, R. E.; Rozanov, A. G.; Shvindt, N. N. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 7: 198-201(Aug. 1967). (In Russian).

The measurement of the electron concentration in stationary argon plasma jets of the electro-arc plasmatron was accomplished by two independent methods: by means of a laser interferometer, usually used for diagnostics of nonstationary plasmas, and broadening of the H_β hydrogen line. The modulation of the plasma parameters necessary for the interferometric measurement is done by closing the arc gap of the plasmatron. Since the sensitivity of the interferometer was insufficiently high (at plasma thickness ~2 mm), the measured value of the electron concentration (1.75×10^{17} cm^{-3}) fits a regime of repeated ignition of the plasmatron arc during increase of the voltage on the capacity modulation. This value N_e agreed well with the values of electron concentration (1.5×10^{17} cm^{-3}) determined by means of the extrapolation of the dependence of N_e on the specific energy of the jet in the area of specific energies, correlating with the spark-over of the arc gap of the plasmatron. The error of the experiment was determined by the possibility of the calculation of the interferential peaks and their effects, the precision of the measurement of the jet thickness, and the contribution of neutral atoms in the measurement of the index of refraction. (tr-auth)

5315 MORE ON PLASMA DIAGNOSTICS BY THE SELF-REVERSED CONTOURS OF SPECTRAL LINES (REPLY TO N. G. PREOBRAZHENSKII). Ilin, G. G.; Fishman, I. S. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 98-9(July 1967).

Translated from Opt. Spektrosk., 23: 183-4(July 1967).

Criticisms of Preobrazhenskii (Opt. Spektrosk. 21, 134(1966)) of the methods developed in Opt. Spektrosk. 20, 214(1966) are answered. Topics discussed include "a", log 2S vs log 2t, σ_v, dense plasma, σ_{dop}, separation of curves, effective temperature, and models. (D.L.C.)

5316 SPECTROSCOPIC MEASUREMENT OF HIGH-TEMPERATURE PLASMAS. II. PRELIMINARY EXPERIMENTS. Hirota, Isao. Denki Shikensho Iho, 31: 845-50(1967). (In Japanese).

The electron temperature of the plasma in the torus has been measured with the spectrophotometer reported previously (cf. Bull. Electrotech. Lab. 31, 839-44 (1967)). It is determined to be 20 to 50 eV from the intensity ratio of the helium singlet line to triplet one. The discharge conditions are a supply voltage to the capacitor banks of 20 to 25 kV and an initial gas pressure of 5 to 23 mtorr. Profiles of several lines emitted from stationary discharge have also been measured. The total half widths of the lines, Hg 5461 Å, HeI 5016 Å, and HeI 4922 Å are found to be 0.16, 0.105, and 0.135 Å, respectively. A calibration method of the sensitivity of photomultipliers is presented. (auth)

5317 SPECTROSCOPIC MEASUREMENT OF HIGH-TEMPERATURE PLASMAS. I. EXPERIMENTAL DEVICE. Hirota, Isao; Takemura, Naoshi; Fuji, Sachio; Kawamata, Shuichiro. Denki Shikensho Iho, 31: 839-44(1967). (In Japanese).

A spectrophotometer for the measurement of the ion and electron temperatures of plasmas is described. The profile of a spectral line is measured by crossing a Fabry-Perot etalon with a plane grating, and then the ion temperature is given by the half-width if the broadening of the line is dominated by the Doppler effect. In the corona model plasma, the electron temperature is obtained by the intensity ratio of the spectral lines. Time-history measuring techniques are also adopted in the device. (auth)

5318 THE EVOLUTION OF THE TEMPERATURE AND DENSITY OF ELECTRONS DURING THEIR RESONANCE ON THE SECOND HARMONIC OF THE CYCLOTRON FREQUENCY IN A H-F H_2 PLASMA. Collet, Luc-Henry; Grolleau, Bernard (Faculte des Sciences, Loire-Atlantique, France). Compt. Rend., Ser. A and B, 265: 245-8(July 24, 1967). (In French).

The application of the double probe method permits the determination of the variations in the electron temperature and density in an hf-excited H_2 plasma during an harmonic cyclotron resonance of the electrons. (tr-auth)

5319 INVESTIGATION OF THE SUPERSONIC JET OF RAREFIED ARGON PLASMA. Gol'dfarb, V. M.; Il'ina, E. V.; Kostygova, I. E.; Luk'yanov, G. A.; Silant'ev, V. A. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 111-16(Jan.-Feb. 1967). (In Russian).

Experimental studies were made of a supersonic argon plasma jet flowing into rarefied media. The complete thrust distribution along the jet axis was measured at various temperatures in the plasmatron arc chamber. A spectrometric method was used for determining the axial and radial distribution of the electron temperature and density and of the density of excited atoms. Probe measurements were made in order to obtain data on the temperature and density of electrons at large distances from the end of the nozzle. The design of the experimental device is included. (R.V.J.)

5320 MEASUREMENT OF THE TEMPERATURE OF THE ATOMS AND ELECTRON CONCENTRATIONS IN ARC DISCHARGES USING VOIGT PROFILE OF SPECTRAL LINES. Grechikhin, L. I.; Tyunina, E. S. Zh. Prikl. Spectrosk., Akad. Nauk BSSR, 7: 7-11(July 1967). (In Russian).

A method for the simultaneous determination of the concentration of electrons and the temperature of radiating atoms was developed using Voigt profiles. The limits of utility, and the limitations and errors of the measurement are explained. On an example of an arc discharge at I = 10 A and pressure of 10-mm Hg, the high efficiency of the method is shown. The errors in the measurement of the temperature of the radiating atoms does not exceed 10%, and the concentration of the charged particles does not exceed 50%. It is shown that on the axis of the arc discharge in the positive column at the limits of 10%, local thermodynamic equilibrium occurs. The method worked out can be used both in the presence and absence of thermodynamic equilibrium. (tr-auth)

5321 MULTI-RAY APPROACH TO THE CALCULATION OF THE CONTOUR OF THE REABSORBED SPECTRAL LINES OF PLASMA. Tambovtsev, B. Z. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 7: 1-6(July 1967). (In Russian).

In the investigation of the contour of the lines of optically dense plasmas the mono-ray approach was commonly used. An attempt was made to be released from this limitation. The calculations were made in the framework of the plasma model proposed by Preobrazhenskii. According to this model, the source functions are described in the form $\phi = c\,[1-|2\eta|^m]$, where c is the normalized constant dependent on m and the distance of the ray from the center of the plasma and $\eta = y/2l$ where l is the half chord. The parameter m connects the simple dependence with the degree of inhomogeneity according to Cowan and Dieke. The known source functions for the central beam can describe other light rays, traveling the distance h from the plasma center. At $m < 2$ (for diameter), the plasma range exists where the source function is quadratic. The form of the source function can be kept for all rays having a similar projection of the density perpendicular to the axis of plasma symmetry. The value of the measurement interval h[-a; a] can be evaluated during which the deformation of the contour lies in the limits of the given precision. In particular, for arcs burning at atmospheric pressure, the deformation of the contour is of the order of 10% at h intervals equal to the radius. (tr-auth)

5322 CROSSED INTERFEROMETRIC-SPECTROGRAPHIC METHOD OF STUDYING PHYSICAL PROCESSES. Shukhtin, A. M. (Leningrad State Univ.). Appl. Opt., 6: 1855-60(Nov. 1967).

Methods are described by which the concentration of electrons

in a plasma and the changes in the gas density can be measured by superposing spectrally scanned interference patterns. (auth)

5323 MEASUREMENT OF PLASMA PARAMETERS USING A RADIAL WAVEGUIDE. Mullen, John Harry. St. Louis, Washington Univ., 1967. 144p.

Thesis.

A new microwave method is described in which a radial waveguide is used to measure complex relative dielectric permittivity. The method is especially suitable for making accurate measurements of the permittivity and thus the electron density and effective collision frequency of an ionized flowing plasma cylinder. This new technique minimizes the usual field problem encountered when microwave plasma diagnostics are used. Theoretical and design limitations of this new method are investigated and experimental results are obtained using solid dielectric samples and a radio frequency heated carbon dioxide and argon plasma. The maximum percent standard error of estimate of the permittivity is shown to be less than 4.8% for solid dielectric columns and less than 9.8% for the electron density of the plasma columns. (Disser. Abstr.)

Kinetics of Plasma

Refer also to abstracts 4936, 5065, and 5213.

5324 (CONF-670810-6) NOISE EMISSION OF ELECTRODELESS RING DISCHARGES WITH STATIC MAGNETIC FIELD. Schlueter, H. (Texas Univ., Austin. Dept. of Physics). [1967]. 5p. Dep. CFSTI.

From 8th International Conference on Phenomena in Ionized Gases, Vienna, Austria.

The noise emitted from electrodeless hydrogen ring discharges is studied in the spectral range from 1 kc to 30 Mc and analysed in conjunction with other observational evidence. The investigated range of static magnetic field strength present yields ratios of $\omega_0/\omega = 0 - 2.5$, where ω is the (angular) generator frequency and $\omega_0 = (\omega_H + \omega_e)^{\frac{1}{2}}$ the hybrid proton–electron resonance frequency. (M.O.W.)

5325 (ORO-3110-10) INVESTIGATIONS OF THE HYBRID ION–ELECTRON RESONANCE. Final Report, June 1, 1963–August 31, 1967. Schlueter, Hans; Oakes, Melvin E. (Texas Univ., Austin. Dept. of Physics). Oct. 10, 1967. Contract AT(40-1)-3110. 26p. Dep. CFSTI.

A study was made to establish the occurrence of the hybrid ion–electron resonance in the neighborhood of the geometrical mean of ion and electron cyclotron frequencies by means of relatively simple experimental arrangements, to explore its basic properties, and to achieve realistic analytical descriptions of actual plasma situations. (M.O.W.)

5326 (SC-CR-67-2748) EXPERIMENTAL STUDY OF ELECTRICAL CURRENTS TO A FLAT PLATE IN SUPERSONIC IONIZED FLOW. Burke, A. F. (Cornell Aeronautical Lab., Inc., Buffalo, N. Y.). Sept. 1967. Contract AT(29-1)-789. 53p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

An experimental study was conducted to measure electrical currents to a flat plate in a flowing plasma. The experiments were done in a pressure-driven shock tube at a free-stream electron density of 1.3×10^{11} cm^{-3}. Both ion and electron current saturation were found and the magnitude of the ion saturation current was within 20% of that predicted using continuum, weakly ionized gas flow theories. (auth)

5327 (AD-659875) RADIATION DURING SCATTERING OF CHARGED PARTICLES ON ELECTROMAGNETIC WAVES OF AN ISOTROPIC PLASMA. Gaylitis, A.; Tsytovich, V. N. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated from pp 1-30 of a report. 28p. (FTD-HT-67-55). CFSTI.

The cross section of scattering of longitudinal waves on an arbitrary charge that is moving in a plasma is calculated taking into account the nonlinearities of the plasma. The change in the cross section of Cherenkov radiation of longitudinal waves by a charged particle that occurs due to nonlinear effects is examined. The obtained results are valid for any velocities of particles and any phase velocities of waves. Through the cross sections calculated, one can then obtain the kinetic equations that describe the nonlinear effects in a plasma of any temperature, including ultrarelativistic temperatures. These nonlinear equations consider both the effects of the interaction of longitudinal waves and the effects of the nonlinear interaction of transverse and longitudinal waves. The obtained results are used to evaluate the role of nonlinear effects and the acceleration of cosmic rays by plasma waves. (auth)

5328 (NP-tr-1598) SCATTERING OF ELECTROMAGNETIC WAVES BY PLASMA WAVES. Filippov, G. M. Translated for Culham Lab., Abingdon, Eng., from Vestn. Mosk. Univ., Ser. III. Fiz. Astron., 22: No. 3, 15-22(1967). 12p. (CTO-408). Dep. CFSTI. UK. JCL $1.60 fs, $0.80 mf.

The scattering of an electromagnetic wave by a plasma wave is considered from the point of view of a system of nonlinear Vlasov equations for an anisotropic plasma when the directions of propagation of both waves coincide. In the limiting case of a semi-infinite space absorption of the incident wave energy by a composite wave is observed. The conditions are determined under which the electromagnetic wave in a perturbed plasma is modulated in space, and the period of the modulation is indicated. (auth)

5329 (UCRL-Trans-10139) CASCADE EXCITATION OF THE HYDROGEN ATOM BY PASSAGE THROUGH A PLASMA TARGET. Grechukin, D. P.; Karpushkina, E. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated by T. Watt for Univ. of California, Lawrence Radiation Lab., Livermore, from report IAE-1364. 79p. Dep. CFSTI. JCL $7.60 fs, $2.57 mf.

An analysis is presented of the cascade excitation of the hydrogen atom by passage through a plasma for the following cases: (a) the plasma is in a magnetic field, which produces ionization of highly excited states; and (b) there is no magnetic field in the plasma. The objects are to elucidate the main features of cascade excitation and the possibility of using this excitation mechanism in the injection of neutral atoms into a magnetic trap. The rapid-flight method is used to estimate the cross sections for ionization of highly excited hydrogen atoms by the fields of atoms and ions, and also of electric dipoles and quadrupoles. (auth)

5330 EXPERIMENTS WITH A HIGH-CURRENT PULSED ARC. Alikhanov, S. G.; Konkashbaev, I. K.; Estrin, B. S. (Inst. of Nuclear Physics, Novosibirsk, USSR). Teplofiz. Vys. Temp., 5: 410-17(May-June 1967). (In Russian).

A pulsed, high-current hydrogen arc was investigated. It is demonstrated that after an initial unstable stage, the discharge becomes stable and is characterized by a large amount of contamination. It is determined that, at maximum current, half of the gas kinetic pressure of the plasma is maintained by the pinch effect. An ion density of about 10^{18} cm^{-3} and maximum plasma temperature of about 2×10^{5}°K were measured. A study of the energy decay indicates severe blocking of radiation by multiply charged impurity ions. A description of the experimental arrangement is given. (ATD)

5331 ELECTROPHYSICAL PROPERTIES OF SHOCK-WAVE-IONIZED ARGON IN A CONSTANT MAGNETIC FIELD. Krylov, V. V.; Tusnov, Yu. I. (Moscow State Univ.). Teplofiz. Vys. Temp., 5: 393-400(May-June 1967). (In Russian).

A shock tube is used as the basis for an arrangement used to measure the parameters of an shf signal in shock-wave ionized argon situated in a constant 5200-Oe magnetic field. Measurements were made at 8161 MHz using an H_{01} type wave. A sharp weakening of shf attenuation as compared to cyclotron frequency and frequency of the electromagnetic wave, ω_H/ω_1, was obtained. Measurement curves are given for the absolute coefficient of reflection and absorption coefficient as a function of the magnetic field. The experimental arrangement is described in general terms only. (ATD)

5332 DETERMINATION OF THE STABILIZATION TIME OF A NONEQUILIBRIUM STATE AT THE INPUT OF AN MHD GENERATOR CHANNEL. Bityurin, V. A.; Ivanov, P. P. (Inst. of High Temperatures, Moscow). Teplofiz. Vys. Temp., 5: 418-22(May-June 1967). (In Russian).

The stabilization time is determined for the case when the heating of the electron gas occurs only due to the Joule heat, and the energy transfer from the hot zones into cold zones by means of electron heat conductivity and radiant heat exchange has no substantial influence. The disregard of the transfer processes makes it possible to simulate the channel input by including a constant electric field in a homogeneous stationary plasma. The problem is reduced to the determination of the stabilization time in a homogeneous stationary plasma of a nonequilibrium state with an elevated electron temperature and degree of ionization after the introduction of an electric field. It is concluded that in order to determine the stabilization time it is sufficient to study two equations: the energy equation and the balance equation of the number of particles for the electrons. The population of the excited levels may be assumed to be in equilibrium to the relative electron temperature. It is sufficient to take into account three excited levels to assure sufficient accuracy for cesium atoms in the determination of the recombination coefficient. Under the conditions of the experiment the stabilization time is approximately 3×10^{-4} sec which, with typical velocities, corresponds to a length of the input section amounting to several tens of centimeters. (ATD)

5333 TIME CHARACTERISTICS OF THE RADIATION OF A PULSED DISCHARGE PLASMA IN VACUUM. Derevshchikov, V. A. (All-Union Scientific-Research Inst. of Electromechanics, Moscow). Teplofiz. Vys. Temp., 5: 423-32(May-June 1967). (In Russian).

Luminescence of pulsed strong-current plasma between coaxial geometry electrodes with vacuum chamber pressure of 10^{-3} to 10^{-6} mm Hg was investigated. Oscillographic studies of various spectral lines were made simultaneous with the high-speed photorecording of the discharge. Time distribution dependence of excitation temperature in the pre-anode and pre-cathode discharge zones was analyzed and spectral lines found for determining the temperature at various moments of discharge. (R.V.J.)

5334 CALCULATION OF THE VISCOSITY INDEX OF CESIUM IN A BROAD RANGE OF TEMPERATURES AND PRESSURES. Avilova, I. V.; Belov, V. A. (Inst. of High Temperatures, Moscow). Teplofiz. Vys. Temp., 5: 433-6(May-June 1967). (In Russian).

The use of alkali metals as working substances in thermionic and MHD energy converters arouses interest in the thermodynamic and transferable properties of these metals. There are almost no experimental data on this subject, due to the difficulty of experimenting with alkali metals at temperatures above 1000°C, forcing investigators to use calculation estimates. In the temperature and pressure range studied, cesium plasma represents a three-component mixture of atoms, ions, and electrons (Cs_2 molecules are disregarded). Cesium atom collision integrals are calculated as statistical means for the configurations $^1\Sigma$ and $^3\Sigma$. The values of the cesium viscosity index calculated up to 10,000 C are tabulated, as are the values of the collision integrals $\sigma^2\Omega_{aa}^{(2,2)*}$ and $\sigma^2\Omega_{ai}^{(2,2)*}$. The values obtained for the viscosity index of a partially ionized cesium plasma are obtained on the basis of the more reliable initial data available and are therefore recommended for application. (ATD)

5335 INFLUENCE OF GAS PASSAGE THROUGH DISCHARGE ON THE PROPERTIES OF A PLASMATRON. Suyarov, N.; Umarov, G. Ya. (Inst. of Physics and Technology, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 5, 70(1967). (In Russian).

Experimental studies of basic rotational plasmatron parameters indicated certain variations in the electrical parameters during passage of gas through the radially rotating arc. Graphical data are given on rotating arc parameters as functions of the gas consumption, the voltage drop on the arc as a function of the air consumption, and plasma ring rotation frequency as a function of the nitrogen consumption. (R.V.J.)

5336 DYNAMIC CHARACTERISTICS OF AN AC PLASMATRON ARC. An'shakov, A. S.; Dautov, G. Yu. (Inst. of Theoretical and Applied Mechanics, Novosibirsk, USSR). Teplofiz. Vys. Temp., 5: 505-9(May-June 1967). (In Russian).

Consideration is given to the use of experimental data on dc arcs in the design of an ac plasmatron. Conditions are investigated when data on the static volt–ampere characteristics of a dc arc may serve as a basis for plotting the dynamic characteristics of an ac arc. Application to a nitrogen arc in a single-chamber plasmatron is treated. (ATD)

5337 INVESTIGATION OF THE TEMPERATURE AND THE SHAPE OF CROSS SECTION OF AN ELECTRICAL ARC COLUMN MOVING IN A MAGNETIC FIELD ALONG PARALLEL ELECTRODES. Slovetskii, D. I. Teplofiz. Vys. Temp., 5: 401-9 (May-June 1967). (In Russian).

Spectral measurements were made to determine the temperature gradient and electron concentration in a high-current electric arc (300 to 2000 amp) along parallel copper electrodes in air under atmospheric pressure in transverse magnetic fields. The temperature outline along the width of the arc was measured using SP-64 photoelectric spectrometer. The results showed that the rate and intensity of the arc are described by the empirical formulas: $V = 0.0425\sqrt[3]{I}\sqrt{H}$ and $U = 24 + [9.2 \times 10^2(V + 10)/\sqrt{I}]l_{gap}$. (R.V.J.)

5338 STATISTICAL THEORY OF PLASMA TURBULENCE. Sasakura, Yutaka (Japan Atomic Energy Research Inst., Toyko). Progr. Theor. Phys. (Kyoto), 38: 576-83(Sept. 1967).

A turbulence theory of the longitudinal waves in electron plasma is developed from the statistical point of view. The fluid dynamics of a one-dimensional compressible nonviscous plasma is represented in terms of classical field theory. The entropy of turbulence measuring the degree of turbulent randomness is introduced and a functional canonical phase distribution is derived as the phase distribution maximizing this entropy of turbulence. By using this phase distribution a turbulent energy spectral density of the electric field is approximately calculated. As a result, the modulus of the canonical phase distribution indicating the degree of turbulence is simply expressed in terms of the average number density, the temperature, the Debye wave number and the turbulent energy density per unit volume. The characteristics of this spectrum are discussed in detail. (auth)

5339 C–G–L APPROXIMATION (HYDROMAGNETIC WAVES IN COLLISIONLESS PLASMA). Tajiri, Masayoshi (Univ. of Osaka Prefecture). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: Spec. Ed., A79-92(Dec. 1966). (In Japanese).

A collisionless plasma is treated as a hydrodynamical system in the Chew–Goldberger–Low approximation. The propagation of hydromagnetic waves is investigated within the frame of this approximation. There exist the fast and the slow magnetoacoustic waves and the Alfvén wave as well as two degenerate waves which propagate with fluid velocity. The hydromagnetic waves propagating along an external magnetic field are also considered on the basis of the Maxwell and Vlasov equations. The adequacy of Chew–Goldberger–Low approximation is discussed briefly. (NSA of Japan)

5340 THEORY OF SPATIAL AMPLIFICATION OF WAVES IN THE ELECTRON BEAM–PLASMA SYSTEM. Kotsarenko, N. Ya.; Fedorchenko, A. M. Radiotekh. Elektron., 12: 1280-3(July 1967). (In Russian).

It is shown that in plasma waveguides with finite metallic walls containing electron beams both of specified radii, there are amplified waves with space charge. The reduction coefficient of these waves is almost equal to unity. (J.S.R.)

5341 PROPAGATION OF ELECTROMAGNETIC WAVES IN A CYLINDRICAL PLASMA WITH MAGNETIC FIELD. Weinhardt, Karl (Institut fuer Plasmaphysik, G.m.b.H., Garching, Ger.). Z. Naturforsch., 22a: 1592-9(Oct. 1967). (In German).

Propagation of circularly symmetric electromagnetic modes parallel to the magnetic field lines in the positive column of an argon hollow-cathode arc discharge has been studied. The applied frequency (3×10^9 cps) was less than both the electron gyrofrequency and the electron plasma frequency. These measurements were compared with dispersion relations for circularly symmetric modes calculated by using the complete Maxwell equations, the ϵ-tensor for a cold collisionless plasma, and suitable boundary conditions. It could be shown that the mode which was excited was most likely determined by the boundary of the coupling system and not by the boundary of the whole vessel as originally expected. (auth)

5342 PRESSURE BUILDUP IN A STATIONARY MAGNETIC-FIELD-STABILIZED HELIUM DISCHARGE BY MEANS OF MAGNETIC MEASUREMENTS. Klueber, Otto (Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch., 22a: 1599-1612(Oct. 1967). (In German).

A stationary discharge is produced by a current flowing parallel to the magnetic field of a cylindrical coil. In the region where the field is homogeneous the pressure in the plasma column is much higher than that in the surrounding neutral gas. This is mainly caused by diamagnetic ring currents, as is shown by measuring the magnetic flux due to these currents. Two effects are primarily responsible for the ring currents in this region: The already known effect of the ambipolar diffusion across the magnetic field and a thermomagnetic effect, called Nernst effect, whose influence on the pressure buildup of a plasma has not been investigated hitherto. Other phenomena causing ring currents occur in the plasma near the coil ends and outside the field coil. (auth)

5343 TEST-PARTICLE THEORY FOR QUANTUM PLASMAS. Rensink, Marvin E. (Univ. of California, Los Angeles). Phys. Rev., 164: 175-81(Dec. 5, 1967).

The analysis of a classical plasma in terms of dressed test particles is well known. The theory is extended to inhomogeneous quantum plasmas with Coulomb interactions between particles. The Wigner one- and two-particle distribution functions are expressed in terms of a test-particle response function for the plasma. The results for homogeneous systems and for classical systems are obtained as special cases of the general result. A superposition theorem for fluctuations is also given. (auth)

5344 STUDY OF THE TEMPERATURE DEPENDENCE OF ELECTRON–ION RECOMBINATION IN NITROGEN. Kasner, W. H. (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 164: 194-200(Dec. 5, 1967).

The temperature dependence of the afterglow decay of electrons and ions from microwave discharges in nitrogen-neon gas mixtures has been studied using combined microwave and mass-spectrometric techniques. Under conditions where N_2^+ is the only significant afterglow ion species, i.e., at nitrogen pressures less than 10^{-2} torr, and for neon pressures in the range 15 to 40 torr, the afterglow is controlled by the recombination of N_2^+ ions and

electrons. Over the temperature range studied, 205 to 480°K, the recombination coefficients exhibit no significant temperature dependence and can be represented by the constant value $\alpha(N_2^+) = (2.7 \pm 0.3) \times 10^{-7}$ cm^3/sec. At any given temperature the results show no systematic dependence on the nitrogen or neon gas pressure over the ranges indicated. Temporal mass analysis indicates similar decay rates for the N_2^+ ions and for the electrons over the major portion of the afterglow. (auth)

5345 PARAMETRICALLY EXCITED PLASMA FLUCTUATIONS. DuBois, D. F. (Hughes Research Labs., Malibu, Calif.); Goldman, M. V. Phys. Rev., 164: 207-22(Dec. 5, 1967).

The enhancement of the spectrum of density fluctuations in a parametrically excited plasma is studied using the linearized theory. In the particular case studied, the plasma is "pumped" by a monochromatic electromagnetic field of either transverse or longitudinal polarization with frequency $\omega_0 \simeq$ (electron plasma frequency) + (ion acoustic frequency). A strong enhancement of the fluctuation power at the two individual frequencies is predicted as the previously calculated threshold for instability or oscillation of the linearized theory is approached. The experiments of Stern and Tzoar and other recent theories are discussed. Approximate expressions are derived for the strength of the enhanced resonances and the range of k vectors which actively participate. The cross section for inelastic scattering of radiation from the excited plasma is derived and compared with a result due to Berk, who did not consider the important regenerative process of parametric amplification. The saturation of the noise level for pump powers above the linear threshold is treated. (auth)

5346 CONNECTION BETWEEN THE SPATIAL DISPERSION AND THE LANDAU DAMPING. Rolland, Paul (Service d'Ionique Generale, Essone, France). Compt. Rend., Ser. A and B, 265: 242-4(July 24, 1967). (In French).

It is shown that the energy dissipation due to spatial dispersion is identical to the dissipation due to Landau damping for large waves; this confirms the purely kinematic character of the Landau damping and correlates the microscopic and macroscopic theories. (tr-auth)

5347 DOPPLER SHIFT IN A PLASMA. Manz, Bruno (Holloman AFB, N. Mex.). J. Opt. Soc. Amer., 57: 1543-50 (Dec. 1967).

It is first shown that the ideal electron plasma (presence of protons neglected) is unique among all dispersive media in that it does not distinguish any inertial frame of reference in terms of utility. The theory of the Doppler shift in an ideal plasma is then developed by simultaneous employment of two inertial frames of reference. In this way, certain remnants of paradoxes in the literature, such as energy dissipation for emitter frequencies greater than the plasma frequency, are removed. The theory is then extended by applying the principle of conservation of frequency. This makes it possible to establish the relation between the emitted and received frequency of an emitter and receiver which move at arbitrary speeds through a plasma that may be heterogeneous and may display unremovable anisotropy because of flow fields that cannot be eliminated by transformations. (auth)

5348 DECAY OF THE ELECTRON STREAM IN LOW-VOLTAGE ARC PLASMA. Gvozdover, S. D. Radiotekh. Elektron., 12: 1499-1501(1967). (In Russian).

The observed unexpected decay of the electron stream was attributed to the self-excitation of straightline incremental electron waves caused by their reflection from strongly ionized layers, beyond which the stream could not be identified. Discharge lead to a homogeneous plasma. It was shown that under certain conditions, as the reflected waves are returned to the point of entry into the plasma, fluctuations are created, the shot-noise generated amplitude and phase of which satisfies the conditions of self-excitation. A one-dimensional, low-voltage, low-pressure arc was examined; the potential minimum at the cathode depressed the shot noise and the electron-stream-excited noises in the plasma. These noises may be decomposed into fluctuations which conserve their phase and amplitude for a relatively long period. The fluctuations then develop further into waves, the parameters of which satisfy the dispersion equation. In the proposed mechanism of the decomposition of the beam, the volume fluctuations play the role of seeding centers. (TTT)

5349 SOME PHYSICAL PROPERTIES OF PLASMA IN CESIUM VAPORS. Morgulis, N. D. (Kiev State Univ.). Ukr. Fiz. Zh., 12: 1627-34(Oct. 1967). (In Russian).

A brief review of some physical properties of plasma in cesium vapors is presented. (auth)

5350 INVESTIGATIONS OF COLLECTIVE INTERACTION OF ION BEAMS WITH PLASMA. Gabovich, M. D.; Kirichenko, G. S.; Pashitskii, E. A.; Protsenko, I. M. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 1659-67(Oct. 1967). (In Russian).

The experimental results are presented of collective interaction of ion beams with plasma obtained in the Institute of Physics, Ukrainian Academy of Sciences, within recent years. The data are briefly considered of two-beam ion instability caused by the interaction of an ion beam with plasma as well as of the interpenetrating neutralized ion beams. The results confirm the relevant theory. The cited data on the interaction of "slipping" ion beams travelling with different velocities along a magnetic field testify to the fact that the effect observed is due to the low-frequency branch of "slipping" instability. (auth)

5351 REVIEWS OF THE WORKS ON THE HARMONIC RADIATION OF A MICROWAVE DISCHARGE. Chiyoda, Katuji (Electrotechnical Lab., Tokyo). Denki Shikensho Iho, 31: 899-903(1967).

Results of about 50 publications, theoretical and experimental, on harmonic generation in a microwave gas discharge are summarized. (auth)

5352 KINETIC THEORY OF ELECTROMAGNETIC WAVES IN A LAYERED PLASMA MEDIUM. Kondratenko, A. N.; Onishchenko, I. N. Zh. Tekh. Fiz., 37: 1205-12(July 1967). (In Russian).

Maxwell's equations and the linearized kinetic equations for small deviations of the electron and ion distribution functions from the equilibrium values were used to discuss the propagation of plane polarized electromagnetic waves through a medium consisting of alternate layers of plasma (with no external magnetic field) and linear dielectric. The propagation direction of the waves is assumed to be perpendicular to the layers, and calculations are performed both for the case of an infinite medium and for a medium that is bounded by a conducting cylinder whose axis is perpendicular to the layers (a "laminated" waveguide). The boundary conditions adopted for the distribution functions at the plasma–dielectric boundaries can be made to represent either diffuse or specular reflection of the plasma particles by appropriate choice of a parameter value. A dispersion equation is obtained and its solution is discussed in some detail for several special cases. It is shown that in the case of thick layers of cool plasma the damping due to Cherenkov absorption of energy by the plasma electrons is inversely proportional to the thickness of the layers and directly proportional to the cube of the electron thermal velocity in the case of specular reflection of the plasma particles at the plasma–dielectric boundaries, and to the first power of the electron thermal velocity in the case of diffuse reflection. The positions and widths of the pass bands of a "laminated" waveguide in the case of thin layers of hot plasma are shown to depend on the boundary conditions (specular or diffuse reflection) at the plasma–dielectric boundaries. (ATD)

5353 ENERGY RELAXATION OF AN ELECTRON CATHODE BEAM IN A WEAKLY IONIZED PLASMA. Baksht, F. G.; Igitkhanov, Yu. L. (Inst. of Semiconductors, Leningrad). Zh. Tekh. Fiz., 37: 1298-1303(July 1967). (In Russian).

The methods, notation, and some of the results of an earlier paper by Baksht, Moizhes, and Nemchinskii (Zh. Tekh. Fiz., 37: 729(1967)) on the distortion by a potential barrier of the energy distribution of electrons emitted from a weakly ionized plasma are employed to discuss the energy distribution of electrons emitted into a plasma through a potential barrier from a cathode. There is considered the case when the energy relaxation of the injected electrons (due mainly to electron–electron collisions) is much slower than the momentum relaxation (due to elastic electron–atom collisions) and a considerable fraction of the emitted electrons can be reflected back to the cathode. The energy distribution of the electrons emitted into the plasma from the cathode is calculated under these conditions and an expression is derived for the current. Inelastic electron–atom collisions are discussed and there are presented the results of a calculation of the rate of excitation of atoms by electron impact in the vicinity of the cathode under the assumption that the excitation cross section is large. (ATD)

5354 INVESTIGATION OF A CONICAL ELECTRODE PLASMA SOURCE. Guzhovskii, I. T.; Gaidukov, V. F.; Belan, N. V. Zh. Tekh. Fiz., 37: 1239-43(July 1967). (In Russian).

The operation of plastic conical plasma guns having different vertex angles ranging from 22 to 54° and spiral conductors to carry off the discharge current was investigated. The altitude of the cone of each of the plasma guns was 6.5 cm. Two series of plasma guns were investigated: in one series the pitch, and in the other series the length of the turns, of the spiral conductors was held constant, independent of the vertex angle. The plasma guns were fixed into an 8-cm-diameter glass drift tube

under a vacuum of 2×10^{-5} mm Hg by the 3- to 12-kV discharge of a 3-μF capacitor. The plasmas were studied with magnetic probes and by observation of the cutoff of 8-mm microwaves. Plasma velocities up to about 2.7×10^7 cm/sec were measured. It was found that there is an optimum vertex angle of about 35 to 45° for maximum plasma velocity; this optimum vertex angle was different for the two series of guns (as was also the maximum plasma velocity) but it was independent of the potential to which the capacitor was charged. (ATD)

5355 ELECTROMAGNETIC WAVE PRODUCTION IN PLASMA DURING SCATTERING OF LONGITUDINAL PLASMA WAVES BY LONGITUDINAL PLASMA WAVES. Wagner, R. (Univ., Kiel). Z. Naturforsch., 22a: 1372-91(Sept. 1967). (In German).

Special interactions of plasma waves are examined in a plasma consisting of protons and electrons in thermodynamic equilibrium. Collisions of particles are neglected. The following two cases are computed: (a) interaction of two plane plasma electron waves with each other; (b) interaction of one plane plasma electron wave with the thermal fluctuations of the plasma which are represented by thermal plasma electron and ion waves. The electric field originating from the interactions is described by an equation obtained from the system of the Maxwell–Vlasov equations for protons and electrons. This equation is solved for the transverse electric field at large distances assuming that the potential energy gained by an electron in the plasma waves is small compared with its thermal energy. For case (a) electromagnetic radiation is emitted near $2\,\omega_{pe}$ where ω_{pe} is the electron plasma frequency. For case (b) the thermal plasma ion waves yield radio emission close to ω_{pe}, whereas the thermal plasma electron waves yield emission close to $2\,\omega_{pe}$. The intensities and scattering cross sections for case (b) are compared with the results of other authors. (auth)

5356 PHYSICAL FOUNDATIONS OF PLASMA APPLICATIONS FOR GENERATION AND AMPLIFICATION OF MICROWAVES. Kislov, V. Ya.; Bogdanov, E. V.; Chernov, Z. S. (Inst. of Radiotechnique and Electronics, Moscow). Advan. Electron. Electron Phys., 21: 287-332(1965).

Topics covered are: slow waves in plasma, interaction of slow waves with electron stream, plasma traveling wave tube, plasma backward wave generator, interaction on longitudinal waves, operating-wavelength shortening problems in plasma devices, and experiments on amplification and generation of millimeter band oscillations by means of plasma. (M.H.R.)

5357 EXPERIMENTS CONCERNING EQUILIBRIUM AND NONEQUILIBRIUM CONDUCTIVITY IN A SEEDED, THERMALLY IONIZED GAS. Sakao, Fujihiko (Tokyo Univ.). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: Spec. Ed., A58-72(Dec. 1966). (In Japanese).

Measurements of conductivity were made in a plasma composed of argon or helium seeded with potassium vapor. The gas temperature was between 1300 and 1700°C; the pressure, 1 atm; and the potassium concentration was between 0.01 and 0.5 mole %. The current density ranged from 10^{-5} to 2 A/cm^2. It was found that the current density–conductivity relation can be divided into three parts according to the value of current density: (1) At a small current density, conductivity is independent of the current density but strongly dependent on the gas temperature; (2) At a large current density electrons are heated to a higher temperature through the Joule heating. It is the electron temperature that determines the fraction of ionization. Thus the conductivity increases with the current density, and depends only weakly on the gas temperature. (3) At intermediate current density electrons are heated, but since their number density is relatively small, the fraction of ionization is still determined by the gas temperature. On the other hand, in argon at those temperatures of this experiment, mobility of electrons is reduced by heating of electrons. Thus, in this region, conductivity decreases with increasing current density. (NSA of Japan)

5358 STUDIES ON THE THERMAL EQUILIBRIUM OF A PLASMA JET. Kanzawa, Atsushi; Kimura, Itsuro (Tokyo Univ.). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: Spec. Ed., A20-8(Dec. 1966). (In Japanese).

Investigations were made on the thermal equilibrium of an argon plasma jet at atmospheric pressure. Probe measurements were conducted to know the ion particle density distribution which is compared with that calculated from the temperature distribution on the basis of the assumption of thermal equilibrium. The conclusion is obtained that the thermal equilibrium is realized only inside the plasma jet except its outer edge where extremely large density of ions is found. (NSA of Japan)

5359 SHOCK HEATED Ar–K AND N_2–K PLASMAS IN TRANSVERSE MAGNETIC FIELD. Imani, Kazutake (Tokyo Shibaura Electric Co., Ltd.). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: Spec. Ed., A49-57(Dec. 1966). (In Japanese).

It has been found that the ionization relaxation time in Ar–K and N_2–K plasmas may be offset by heating the driven section of the conventional pressure-driven shock tube. Precursor electrons were observed 30 cm ahead of the shock front by the axially distributed electrical floating probes. With nine pairs of Faraday-type electrodes and four floating probes the electrical conductivity was found to be two orders of magnitude greater than the equilibrium value, when the gas had an impurity level of less than 100 ppm. At the same time, the momentum-transfer collision-cross-sections of electron for Ar, K, and N_2 were found to be 0.8, 250, and 6(Å^2) respectively from measurements of the Hall parameter and using a bulk plasma diagnostic analysis. The cross-section for Ar is higher than the value from dc discharges because of the strong dependence on the electron energy. An alternative method of nonequilibrium MHD power generation is proposed for both closed and open cycles, in which the long lived electronic and vibrational excited N_2 are produced by an auxiliary discharge and gradually transfer their energy to ionize the K as the plasma passes through the generator. The shock tube studies determined the relaxation time of the electrical conductivity to be about 5 msec, as the conductivity decreased to approximately 10 mhos/m in Ar–N_2–K plasma and to 1 in N_2–K or at 1500°K. This is in reasonable agreement with the theory, although the reaction cross-section were unknown precisely. (NSA of Japan)

5360 IONIZATION AND RECOMBINATION PROCESS IN A NONEQUILIBRIUM FLOW. Shioda, Susumu (Tokyo Shibaura Electric Co., Ltd.). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: Spec. Ed., A12-19(Dec. 1966). (In Japanese).

A system of equations of nonequilibrium reacting, slightly ionized plasma is derived on several assumptions and is applied to the calculation of one-dimensional flows. As an example, the inlet flow (10^5 m/sec) of argon (1 atm) seeded with potassium (10^{16} cm^{-3}) in the presence of transverse magnetic field is considered and the relaxation of ionization and the electron temperature are calculated. These are typical conditions of MHD nonequilibrium power generation. The radiant electron energy loss is also taken into account. The results of the calculation show that the inlet length of the relaxation is from 3 cm to 30 cm in this case when $\omega\tau$ is from 5 to 2.5, respectively. But this length becomes shorter when the seeding is reduced. The case of local equilibrium corresponding to infinite reaction rate is also investigated. The necessary length is about the half of that in the finite reaction case. (NSA of Japan)

5361 EXPERIMENTS ON MHD POWER GENERATION WITH POTASSIUM-SEEDED ARGON PLASMAS. Matsunaga, Sakuro (Japan Atomic Energy Research Inst., Tokyo). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: Spec. Ed., A36-48(Dec. 1966). (In Japanese).

The electrical conductivities obtained from the experiments on MHD power generation with potassium-seeded argon plasmas have been compared with ones directly measured. The gas temperatures are 2000 ~ 2500°K; the pressure, 1 atm; the seeding ratios, $(0.5 \sim 2.5) \times 10^{-3}$; and powders of potassium carbonate are used as the seed material. In the experiments on the power generation, the electrical potential distributions in the plasma have been measured for the open and short circuits of the generator. The conductivities of the plasma in applied electric fields have been directly determined by the measurement of both voltage drops developed due to the current in the plasma and quality values of an rf coil coupled with the plasma. This method of measurement gives an information on the distributions of conductivity and current density in the plasma. According to the results of the direct measurement of conductivities, it should been concluded that in Ar–K_2CO_3 plasma the nonuniformity of the conductivity accompanied by the constriction of the current appears at low current densities (j = 0.6 ~ 4 A/cm^3). Even in the constriction of the current, the experimental values of conductivity almost agree with the values calculated with a two-temperature model, in which the collision losses by impurity molecules such as CO_2, CO and O_2 and the radiation losses by potassium atoms are taken into account. The values of conductivity estimated from the experimental data on the power generation are much less than those directly measured. This disagreement has been qualitatively explained on the assumption that the nonuniformities of conductivity present in the plasma in the generator channel. (NSA of Japan)

5362 EQUATIONS FOR WAVES IN AN INHOMOGENEOUS WARM MAGNETOPLASMA WITH UNIAXIAL PRESSURE. Burman, R. (Victoria Univ., Wellington, N. Z.). Proc. IEEE (Inst. Elec. Electron. Eng.), 55: 2022-3(Nov. 1967).

Waves in a warm electron magnetoplasma are considered, the Chem–Goldberger–Low approximation being used. Linearized

equations, applicable when the plasma is inhomogeneous, are obtained; the effect of static pressure variations is included. (auth)

5363 ENERGY DENSITY OF ACOUSTIC WAVES IN A PLASMA. Smith, W. E. (Argonne National Lab., Ill.). Proc. IEEE (Inst. Elec. Electron. Eng.), 55: 2051-2(Nov. 1967).

The energy density of longitudinal waves in a homogeneous plasma is found from a general theory for sound waves in dispersive media. The energy relation of Loungren is then interpreted as the acoustic version of the harmonic Poynting theorem in electromagnetism. (auth)

5364 EXPERIMENTAL STUDY ON A PLASMA FLOW THROUGH A MAGNETIC NOZZLE. Kuriki, Kyoichi (Tokyo Univ.). ITokyo Daigaku Uchu Koku Kenkyusho Hokoku, 29: Rep. No. 380, 7-30(Feb. 1964).

The interaction between a plasma flow and the magnetic field produced by a ring coil was investigated experimentally to confirm the channelling effect of the magnetic field. The plasma flow was produced in a quartz tube by an arc jet. Before imposing the magnetic field on the plasma flow, the flow conditions such as temperature, velocity, and static pressure were measured. The results showed that the flow conditions change only very slowly along the stream, and that the flow is either subsonic or supersonic, depending on the arc current. The distributions of the wall pressure and gas luminosity were calculated numerically by a linearized theory which assumes that there exists only a small effect of the magnetic field on the plasma flow, and which neglects the Hall effect and the charge separation. In the measurements of the wall pressure distribution, a marked contrast between subsonic and supersonic flow was observed, as predicted by the linearized theory. From photographic observations and from gas luminosity measurements, it was found for both the subsonic and supersonic flow that the plasma density decreases near the wall of the quartz tube at locations downstream from the ring coil. This result was explained theoretically. The magnetic channelling effect of a ring coil on the plasma flow was clearly demonstrated. (BBB)

5365 CONDUCTING GAS FLOW IN THE JET BEHIND AN ELECTROMAGNETIC ACCELERATOR. Bam-Zelikovich, G. M. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 8-13(Jan.-Feb. 1967). (In Russian).

Equations are developed for the conducting gas motion in the jet behind the cutoff of an accelerator. The shape of the jet and distribution of all parameters in the jet are found. The problem is resolved with assumption of plane flow, absence of Hall current, and small change of velocity in comparison with the velocity at the outlet of the accelerator channel. (tr-auth)

5366 APPROXIMATE SOLUTION OF STATIONARY INDUCED HIGH-FREQUENCY RING DISCHARGE. Gruzdev, V. A.; Robinskii, R. E.; Sobolev, A. P. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 143-50(Jan.-Feb. 1967). (In Russian).

The boundary problem of stationary induced high-frequency ring discharges was resolved by a method of successive approximation permitted quantitative evaluation of phenomena taking place in the induced discharge. The second approximation was used for numerical calculations of the basic discharge parameters in argon and for correlating results obtained with the experimental data. The problem is set up for a system of cylindrical gas containing an inducer considering that the charge-exciting field is homogeneous along the axis of discharge, that the plasma is stationary, the pressure in the system is constant, the electromagnetic field wave length is much larger than the size of plasma, and the emission energy is negligible compared with the plasma heat losses. (R.V.J.)

5367 SIMULATION METHOD FOR DETERMINING THE CURRENT DISTRIBUTION IN PLASMA. Bortnichuk, N. I. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 141-3(Jan.-Feb. 1967). (In Russian).

An approximation method is suggested for determining the density of a direct current flowing between electrodes in plasma considering the anisotropy of conductivity for plane-parallel or radially symmetric electric and magnetic fields. (tr-auth)

5368 PLASMA OSCILLATION DAMPING IN A MAGNETIC FIELD. Mazitov, R. K.; Fridman, A. M. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 134-5(Jan.-Feb. 1967). (In Russian).

The influence of a weak magnetic field on damping of electron Langmuir oscillations was analyzed. It was found that the magnetic field interfered with setting up a certain plateau of distribution functions and acted, in a way, similar to the collision effect. Thus, in the case of collisions, the damping is a function of the frequency of collisions; in the case examined it became a function of the Larmor electron frequency. The analysis was carried out considering that the one-dimensional spectrum of electron Langmuir oscillations was excited in the plasma during the time $t = 0$, the oscillations were excited in the range of $(k_0, k_0 + \Delta k_0)$ in the space of wave vectors, moreover $\Delta k_0 \ll k_0$. The damping of oscillations was studied using a quasi-linear approximation. (R.V.J.)

5369 INVESTIGATION OF CYLINDRICAL WAVES IN A RAREFIED PLASMA. Berezin, Yu. A.; Kurtmullaev, P. Kh. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 116-24(Jan.-Feb. 1967). (In Russian).

The regularities inherent to cylindrical waves propagating in a cold rarefied plasma are analyzed, and comparisons are made of the experimental data obtained with numerical solutions. The plasma was quickly compressed by an external field created by a shock coil surrounding the area occupied by the plasma. The wave outlines were studied by magnetic probes spaced at various distances from the axis of the system. In the numerical computations the plasma was assumed to be quasi-neutral, completely ionized, cold ($nt \ll H^2/8\pi$) and described by equations for macroscopic motion of electron and ion components and Maxwell equations with self-consistent electromagnetic fields. The problem is set up for the case of transverse propagation of cylindrical waves (or as a one-dimensional problem with all magnitudes as functions of the radius r and time t. (R.V.J.)

5370 DEVICE FOR THE MEASUREMENT OF THE DEGREE OF POLARIZATION OF THE LIGHT RADIATION OF PULSE DISCHARGES. Berezin, A. B. Zh. Prikl. Spektrosk., Akad. Nauk SSSR, 6: 837-9(June 1967). (In Russian).

A device for the measurement of low polarization values of light emitted by pulse discharges is described. The device consists of a Wollaston prism, monochromator, two photomultipliers, and a two-cycle oscillograph with differential amplifier. The photoelectric receiver was calibrated by means of a collection of foils from crystalline quartz which rotates the plane of the polarized light of the appropriate wave length by 90°. The minimum measured value of the degree of polarization of the pulse radiation of the duration of 400 μsec is 1 to 2%. The results on the measurement of the degree of polarization of the recombination continuum of hydrogen were reported. (tr-auth)

5371 STUDY OF THE INSTABILITY RESULTING FROM THE COUPLING OF THE SLOW MODES OF SPACE CHARGE OF AN ELECTRON BEAM WITH THE MODES OF THE WEAKER ELECTRON BAND OF A PLASMA, IN A FINITE GEOMETRY AND IN THE PRESENCE OF A FINITE MAGNETIC FIELD. Bouchoule, Andre; Bliman, Samuel (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. A and B, 265: 183-6 (July 17, 1967). (In French).

Earlier studies of the dispersive properties of a homogeneous medium composed of a plasma and an electron beam ("beam–plasma" medium) confined by a magnetic field showed the different unstable waves that could be developed. This note discusses the existence of the unstable coupling (D) resulting from the interaction between the slow plasma mode associated with the beam and the plasma mode associated with the weaker branch of the dispersion diagram. Two cases are considered: a "beam-plasma" column filling completely a metallic guide and the same column in vacuum. (tr-auth)

5372 COLLISIONLESS SHOCK WAVES IN A RAREFIED PLASMA. Berezin, Yu. A.; Kurtmullaev, R. Kh.; Nesterikhin, Yu. E. Fiz. Goreniya Vzryva, No. 1, 3-28(1966). (In Russian).

The theory of the structure of shock waves, dispersion effects, shock waves with an oscillatory structure, collisionless dissipation, shock waves with an aperiodic profile, conditions for exciting waves, devices used to excite strong shock waves, the basic method of plasma diagnosis, dynamics of cylindrical waves, and the structure of a shock wave and physical phenomena at the front are discussed. The problem of shock waves includes a wide scope of physical phenomena such as dispersion of plasma oscillations, microscopic instabilities, collisionless damping, and others. The interest shown in collisionless shock waves is to a considerable extent due to the fact that instabilities developing at the wave front and the phenomenon of the so-called "reversal" of strong shock waves can lead to an effective dissipation of energy and heating of plasma. The indicated phenomena are also of value for understanding processes occurring in the interplanetary medium, for example the interaction of the solar wind with the geomagnetic field. (ATD)

5373 DIFFUSE CONTINUA-EMITTING DISCHARGES IN THE RARE GASES WITH AND WITHOUT NITROGEN. Kenty, Carl (General Electric Co., Cleveland). J. Chem. Phys., 47: 2545-51(Oct. 15, 1967).

If a current the order of 1 mA is passed through 50 to 750 torr of a pure rare gas in a 10-cm-diam tube a diffuse discharge results

filling the tube and emitting mainly a continuous spectrum, strong in the vacuum uv, weak in the near uv, visible and ir. The discharge is characterized by a very high-voltage gradient and a substantially flat volt–ampere characteristic. The ion and electron concentration is 10 to 10^9 cm^{-3} and the electron energies are high. Energy losses are principally elastic and the ions and electrons reach the wall by ambipolar diffusion. The continuous spectra are of molecular origin. Continua from Xe, Kr, and Ar are whitish, that from Ne a light blue. In any of the above discharges if a critical current is exceeded the discharge goes to a filamentary form. The addition of 0.1% N_2 to the pure rare gas gas profound effects, lowering the gradient in Xe 18-fold and bringing out the arc lines of Xe. New spectral structures are found at 3466 Å, 3650 Å, and at 1.3 μ which are believed to be due to complex molecules of Xe and N_2. There is an afterglow lasting up to 10 sec that is spectroscopically much the same as the discharge itself. A high concentration (10^{13}–10^{14} cm^{-3}) of long-lived energy carriers is indicated and are believed to be mainly $N_2(^3\Delta_u)$. Collisions of pairs of $^3\Delta_u$ with Xe as a third body and/or of $^3\Delta_u$ with $N_2(A)$ produce the higher excited states of Xe and probably Xe_2^+ and higher excited states of N_2 and N atoms. Blue fluorescence of a Pyrex wall indicates strong vacuum uv in Xe. The Vegard–Kaplan (VK) bands are developed with fair intensity indicating a population of $N_2(A)$ of the order of 10^{10} cm^{-3}. The discharges have a positive characteristic indicating that the ions and electrons are disappearing by recombination and that the metastable energy carriers are partially saturated with respect to current. Interruption of the current is followed by an abrupt fall in luminosity to ~1/3 of the initial intensity, followed by a recovery to ~3/4 initial, and then a slow decay of ~1/2 sec. In N_2 + Kr the first negative system of N_2^+ is strongly developed perhaps indicating the presence of a high-energy metastable state of N_2. (auth)

5374 OVERSTABLE MODES DUE TO RESISTIVITY GRADIENTS IN A CURRENT-CARRYING PLASMA COLUMN. Pridmore-Brown, D. C.; McPherson, D. A. (Aerospace Corp., El Segundo, Calif.). Phys. Rev. Lett., 19: 1279-81(Nov. 27, 1967).

A set of overstable modes is found for a low-β current-carrying plasma having high gradients of resistivity. It is suggested that these modes provide an explanation for the large-amplitude spontaneous oscillations that have been observed in a fully ionized current-carrying plasma column. (auth)

5375 HYDROMAGNETIC WAVE PROPAGATION IN A MAGNETICALLY CONFINED PLASMA. Hollis, Daniel Lester Jr. College Station, Tex., Texas A and M. Univ., 1967. 104p.

Thesis.

Theta pinch plasma characteristics are described by equations for the particle density, electric field, and magnetic field as functions of radial position in cylindrical geometry. These equations are based on a position function which relates the ion density to distance from the region of uniform plasma near the centerline of the theta pinch. The product of this position function and a Maxwell–Boltzmann distribution as a function of gyration radius is integrated over a finite range of gyration radii to yield the particle density profile. It is postulated that all ion gyration centers are located within a radial boundary, r_1, and, as a result, the limits of integration are bounded. The particle density profile developed in this way is more nearly monoenergetic than that of the pure Maxwellian distribution. The magnetic induction equation as a function of particle density is obtained from the hydromagnetic formulation of the momentum equation. Consideration of the balance of forces for ions revolving about their gyration centers leads to the equation for the electric field in terms of the particle density. Plasma proper is defined as the region within r_1. Sheath, or boundary layer, is defined as the annular region between r_1 and $(r_1 + h)$, which is the point where the particle density becomes negligible. Plasma energy is calculated with an expression requiring three experimental data: r_1, $(r_1 + h)$, and B_c (magnitude of the compressing induction). There is satisfactory agreement of these results with published experimental data. Simplified hydromagnetic equations are combined with a generalized Ohm's law to produce separate wave equations for the perturbed longitudinal electric and magnetic fields. The two wave equations are linear, second order, and homogeneous, but the variable coefficients prevent analytic solutions. Numerical solutions by use of computers are feasible. (Disser. Abstr.)

5376 ELEKTRICHESKII PROBOI I RAZRYAD V VAKUUME. (Electric Breakdown and Discharge in a Vacuum). Gokhberg, B. M. (ed.). Moscow, Atomizdat, 1966. 300p.

Systematic data are given on the complex physical phenomena of the vacuum isolation of a self-maintained vacuum discharge. The first chapter of the book gives a brief description of the properties of vacuum electrical insulation. Certain elementary processes taking place on the electrode surfaces, which are responsible for the behavior of vacuum electric insulation and lead to dangerous processes are described in the second chapter. The next three chapters cover the experimental data at a constant pulsed and high-frequency voltage. Descriptions of the discharge in a strongly rarefied gas are presented in the seventh chapter. The eighth chapter covers the comparative analysis of various processes which may induce the vacuum breakdown. (R.V.J.)

Production of Plasma

Refer also to abstract 5371.

5377 CAUSES OF RADIATION PEAK FORMATION IN ATOMIC SPECTRAL LINES OF A NONEQUILIBRIUM GAS BEHIND A SHOCK WAVE. Vorob'ev, V. S.; Yakubov, I. T. (Inst. of High Temperatures, Moscow). Teplofiz. Vys. Temp., 5: 517-19(May–June 1967). (In Russian).

A mechanism is proposed to explain the formation of radiation peaks in spectral lines. Pertinent evaluations are made for shock waves in air and are compared with experimental data. This study is based not on the results of investigations on relaxation kinetics, but rather on a novel kinetic scheme and mechanism of electron gas heating. An approximation method presented earlier by one of the authors (Vorob'ev., Zh. Eksperim. Teoret. Fiz., 51: 327(1966)) is used to describe the distribution of atoms with respect to radiation levels. (ATD)

5378 MAXIMUM EMISSION OF A NONEQUILIBRIUM GAS IN THE WAKE OF STRONG SHOCK WAVES. Yakubov, I. T. (Inst. of High Temperatures, Moscow). Teplofiz. Vys. Temp., 5: 515-17(May–June 1967). (In Russian).

Although it is known that the emission of a nonequilibrium gas in the wake of shock waves passes through a maximum, exceeding its value in equilibrium, the phenomenon has not been explained. The present author offers a mechanism of excitation of the emission of a nonequilibrium gas in the wake of strong shock waves, and performs the necessary evaluations and comparisons with experimental results. The following mechanism is proposed: Molecular ions appear during associative ionization, and disappear during recharging and dissociative recombination. If the rate of recharging is high, then all the kinds of ions (atomic and molecular) are in a quasiequilibrium. Since the kinetic temperature of the atoms and ions is high, in this case there are very few molecular ions. However, in practice it is shown that in certain cases recharging proves to be insufficiently effective, in which case the concentration of molecular ions greatly exceeds its values in equilibrium. Excitation of the emitting states of these ions is achieved during collisions with electrons, whose concentrations in the wake of strong shock waves prove to be sufficient. (ATD)

5379 PLASMA OF CESIUM IONIZED BY CONTACT IN A MAGNETIC CONFINEMENT MACHINE: PASCAL. Doucet, H.; Lamain, H. (Ecole Polytechnique, Paris). Rev. Phys. Appl., Suppl. J. Phys., 2: 153-7(Sept. 1967). (In French).

A cesium plasma device is described in which surface ionization and magnetic confinement are used. The device called Pascal is entirely demountable, working in a vapor-pressure mode and was built for the study of ion-wave and associated electrostatic instabilities studies. (auth)

5380 ENERGETIC PLASMAS PRODUCED BY LASER LIGHT ON SOLID TARGETS. Opower, H.; Kaiser, W.; Puell, H.; Heinicke, W. (Technische Hochschule, Munich). Z. Naturforsch., 22a: 1392-7(Sept. 1967).

Using two parallel simultaneously operating giant pulse lasers light intensities of 3×10^{12} W/cm^2 were achieved in the focus on a LiD target. Ion energies in the expanding plasma stream of 4.5 keV were observed. Investigations on thin LiH targets showed that the light pulse interacts only with a target layer several 10^{-4} cm in thickness. The magnitude of the ion flux is estimated and compared with experimental observations. (auth)

5381 NONEQUILIBRIUM IONIZATION IN A LOW-VOLTAGE ARC DISCHARGE. II. Stakhanov, I. P. Zh. Tekh. Fiz., 37: 1286-97(July 1967). (In Russian).

The Wiener–Hopf method is employed to calculate the electron distribution function from the kinetic equation and boundary conditions derived earlier, and the distribution function is employed to calculate the ionization rates. It is found that the nonequilibrium ionization rate, unlike the equilibrium rate, is proportional to the arc current. The calculations are based on the assumption that the inelastic scattering cross section is so small that the changes in the electron distribution function can be regarded as due entirely to electron–electron Coulomb collisions and elastic electron–atom collisions. In the opposite limiting case when the inelastic

scattering cross section is so large that inelastic collision is the predominant process contributing to relaxation of the electron distribution function at energies exceeding the cesium excitation energy, the problem of calculating the electron distribution function when the electrons are emitted from the cathode with a Maxwell distribution is not amenable to treatment by the Wiener–Hopf method. (ATD)

5382 NONEQUILIBRIUM IONIZATION IN A LOW-VOLTAGE ARC DISCHARGE. I. Stakhanov, I. P. Zh. Tekh. Fiz., 37: 1277-85(July 1967). (In Russian).

The ionization of cesium atoms in a low voltage high-pressure cesium arc was investigated in the vicinity of the cathode, where the electron distribution function is distorted by the effect of the cathode drop. It is assumed that the cathode drop is smaller than the first excitation potential of cesium and that the relaxation of the electron distribution function toward the equilibrium (Maxwell) form is due entirely to electron–electron Coulomb collisions. It is also assumed that the electron mean free path for electron–electron Coulomb collisions is much longer than the electron mean free path for electron–atom collisions, that the electrode spacing is much greater than the geometric mean of the two electron mean free paths just mentioned, and that the electron temperature is much lower than the energy associated with the cathode drop. The kinetic equation for the electron distribution function is written and formulas are derived for the local and integral rates of ionization in terms of the Fourier transform of the electron distribution function at the cathode. By way of illustration, the ionization rates are calculated for the case when the cathode emits a monoenergetic beam of electrons. The boundary conditions on the electron distribution function at the cathode surface are derived from a consideration of the current balance in a layer near the cathode. These boundary conditions are such that one must resort to the Wiener–Hopf method in order to calculate the distribution function. (ATD)

5383 TRANSVERSE MAGNETIC FIELD EFFECTS ON VERY FAST ELECTRONS IN A GASEOUS DISCHARGE. Parvan, Radu (Univ. of Bucharest). Rev. Roum. Phys., 12: 537-43(1967). (In Rumanian).

Phenomena leading to the formation of very luminous striations resolved by a magnetic field perpendicular to the direction of the very fast electrons in a low-pressure discharge tube during continuous running were studied. The stria are formed in the negative as well as in the positive column, where they coexist with the customary stria. (tr-auth)

5384 DETERMINATION OF THE TEMPERATURE OF THE PLASMA OF THE WIRE EXPLOSION. Nguyen Van Trong (Compagnie Internationale pour l'Informatique, Courbevoie, France). Compt. Rend., Ser. A and B, 265: 187-90(July 17, 1967). (In French).

An opaque plasma is produced by the wire explosion. Its temperature is determined by three different methods. The current and voltage oscillograms show the existence in certain conditions of two arc phases in the wire explosion phenomenon. (tr-auth)

5385 HIGH TEMPERATURE PLASMA GENERATOR. Matsuda, Jinsaku (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-9747. May 25, 1966. Filed Apr. 12, 1965.

The generator consists of the following: the plasma discharge tube wound with a plasma-containment coil; the device for producing and heating a plasma, which is excited by a pulsed-current generator; an ac source for supplying a plasma-containment current to the containment coil through a current-making device; a circuit for closing the current-making device at a pre-determined phase of the ac source; a circuit for dividing the terminal voltage of the plasma-containment coil; the first and second condensers always charged by a dc source; a discharge device, connected in series to the first condenser and discharge coil, which discharges the first condenser at a predetermined divided voltage of the voltage-dividing circuit; and a circuit, which has a constant-voltage discharge device for discharging the second condenser when the voltage of the first condenser becomes nearly zero. When the current making device is closed at the pre-determined phase of the ac source voltage, the pulsed current generator is actuated at the pre-determined pulse containment current by the use of the discharge current from the second condenser, thereby actuating the device. (NSA of Japan)

Stability of Plasma

5386 (NP-tr-1600) EQUILIBRIUM, STABILITY, AND TRANSPORT PROCESSES IN A PLASMA IN TOROIDAL GEOMETRY. Galeev, A. A.; Sagdeev, R. Z. ([Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki]). Translated for Culham Lab., Abingdon, Eng., from pp 1-14 of a Preprint. 13p. (CTO-416). Dep. CFSTI. UK. JCL $1.60 fs, $0.80 mf.

It is shown that in a sufficiently tenuous plasma in toroidal traps the transport processes, due to binary collisions, may in fact, be speeded up considerably more (factor of order $(R^3/\gamma)^8$). This is attributed to an effective increase in the frequency of the Coulomb collisions for the trapped particles. The stability limit of the plasma is determined with respect to the so-called drift-dissipative instability of trapped particles. From this one can then determine the density limits of a thermonuclear plasma when both classical and turbulent transport processes are fairly small. (M.O.W.)

5387 (UCRL-Trans-10147) CRITICAL ELECTRON-BEAM CURRENTS IN PLASMA. Rayzer, M. D.; Rukhadze, A. A.; Strelkov, P. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated by T. Watt for Univ. of California, Lawrence Radiation Lab., Livermore, from report No. 98. 9p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The stability problems involved in the production of high-current electron beams are described. (M.O.W.)

5388 MODES OF THE SCREW INSTABILITY IN A POSITIVE COLUMN FOR SEVERAL GASES. Kawaguchi, Motoichi; Itoh, Satoshi; Yamamoto, Kenzo (Nagoya Univ., Japan). Jap. J. Appl. Phys., 6: 1439-48(Dec. 1967).

The mode, frequency and wavelength of screw instability are experimentally observed for several gases. These experimental results are compared with the theory modified from that of Kadomtsev and Nedospasov. The modified theory shows good agreement with the experiment. The experimental results are divided into two cases: one is obtained in rare gas and the other is in diatomic gas discharge. For rare gas discharges the mode coincides with the Kadomtsev–Nedospasov's theory, while for diatomic gas discharges the column shows a peculiar mode transformation with increase of longitudinal magnetic field. These experimental results are explained by the modified theory. (auth)

5389 INFLUENCE OF DISSIPATIVE EFFECTS ON FLUTE OSCILLATIONS. Arsenin, V. V.; Timofeev, A. V. Zh. Tekh. Fiz., 37: 1244-51(July 1967). (In Russian).

Dissipative effects (loss of particles from the system by charge-exchange collisions or the development of other instabilities, turbulent viscosity, resonant interaction of the flute oscillations with vibratory motion of the particles, and others) on the flute instability of a mirror-confined plasma were investigated. After a brief qualitative discussion in which it is shown that the presence of an anti-Hermitian part of the dielectric tensor can lead to instability even under "stabilized" conditions in which the density and field strength gradients are oppositely directed, the authors discuss in the two-fluid hydrodynamic approximation the stability of a plane system in which the plasma density and the magnetic field strength depend on only one Cartesian coordinate. Ionic viscosity is taken into account in the equations of motion, which also contain a term proportional to the difference between the ion and electron velocities that represents the friction between the two fluids. There is included in the equation of continuity a term representing loss of particles from the system. An expression is obtained for the dielectric tensor, and stability conditions are derived with its aid. The resonant interaction of the waves with the vibratory motions of the plasma particles is discussed in the final section, and stability conditions are derived for two simplified models. (ATD)

5390 H FUNCTION OF TURBULENCE. Tatsumi, Tomomasa; Ikeda, Norito (Kyoto Univ.). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: Spec. Ed., A73-8(Dec. 1966). (In Japanese).

The H function of turbulence which represents the randomness of turbulence is defined in terms of the probability distribution of turbulent variables. The time derivative of the H function is calculated for turbulences both in incompressible viscous fluid and collisionless plasma. It is found that the H function of turbulence increases monotonically in time for incompressible viscous fluid and stays constant for collisionless plasma. This conclusion may be interpreted as follows: the randomness of turbulence is not increased in time although turbulent fields usually become more and more complicated in time. (NSA of Japan)

5391 NONLINEAR INSTABILITIES IN BEAM–PLASMA SYSTEMS. Aamodt, R. E.; Sloan, M. L. (Univ. of Texas, Austin). Phys. Rev. Lett., 19: 1227-9(Nov. 20, 1967). (ORO-3458-6).

Model equations used to predict instability induced by nonlinear interactions in plasma devices are examined. A necessary and sufficient condition that the usual three-wave resonant scattering equations possess unbounded solutions for arbitrarily small perturbations is derived, which does not depend on the particular model chosen. The condition is specifically applied to systems of electron beams in a plasma without a magnetic field and a weak ion beam in a strong magnetic field. (A.G.W.)

5392 INFLUENCE OF INITIAL PLASMA PARAMETERS ON THE INSTABILITY OF TWO-DIMENSIONAL NONHOMOGENEOUS PLASMA. Moiseev, S. S. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 136-8(Jan.-Feb. 1967). (In Russian).

Instabilities in two-dimensional nonhomogeneous plasma were studied in the case in which plasma drift–temperature instabilities developed as a result of a certain ratio between the initial density and temperature gradients. The most dangerous instabilities were developed with $d \lg T_0/d \lg n_0 > 2$ in the frequency range $\omega < k_z v_T^i$, (where, v_T^i is the ion thermal rate and k_z is the wave vector projection in the direction of the magnetic field H_0). The danger is associated with the abnormal particle diffusion induced by the developing instabilities which remain large even with a strongly stabilizing factor presented by force lines of the crossed magnetic fields. The noncollinearity of density and temperature gradients enlarged the instability area because the total particle flux on the wall was smaller than the thermal flux. Also, additional particle and thermal fluxes developed during operation of the device with plasma magnetism preventing them from dispersing across the field. (R.V.J.)

5393 POWER DISSIPATED OR GENERATED BY DIFFERENT EXCITED MODES IN A PLASMA. Rolland, Paul (Service d'Ionique Generale, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 265: 180-2(July 17, 1967). (In French).

The energy exchanges in a plasma, becoming eventually the site of convective instabilities and a sinusoidal excitation source in time, arbitrary in space, were studied. The results obtained clarify the kinematic theories already developed and give formulas of practical interest. (tr-auth)

Shielding

Refer also to abstracts 4334 and 5869.

5394 (EGG-1183-2163) ENERGY AND ANGULAR DEPENDENCE OF AIR SCATTERED GAMMA RAY DISTRIBUTION FUNCTIONS. Michael, J. A.; Lamonds, H. A. (EG and G, Inc., Santa Barbara, Calif.). Nov. 9, 1967. Contract AT(29-1)-1183. 23p. (CONF-671102-38). Dep. CFSTI.

From 15th Conference on Remote Systems, Technology and Atom Fair, Chicago, Ill.

Both energy and number distribution functions were calculated for 15 source energies in the range 100 keV to 3 MeV for eight penetration distances spanning the range from 3 to 1,000 ft. The angular dependences of all these distribution functions were calculated, as well as number and exposure buildup factors. The calculational technique is reviewed, leading into a discussion of the convergence properties of the calculation. Results obtained for a ^{137}Cs source are presented as a sample of the entire set. This calculation and other calculations made by both the method of moments and Monte Carlo techniques are compared. (TSS)

5395 (EUR-3555e) USER'S MANUAL FOR THE GAMMA TRANSPORT CODES BIGGI 3P AND BIGGI 4T. Penkuhn, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 30, 1967. 139p. Dep.

The BIGGI programs (in Fortran) calculate in plain or spherical multilayer geometry gamma angular fluxes, spectra and response functions, or buildup factors and albedos. They need a 32-K storage, and BIGGI 4T furthermore 4 intermediate tapes. The computing time on the IBM 7090 is about 15 sec per spatial point, and an exponential transformation allows great spatial integration steps, up to 2.5 mfp. In BIGGI 3P the sources are monoenergetic and located on an outer boundary plain; in BIGGI 4T they are volumic and can be rather arbitrary in energy and spatial dependence. Furthermore, BIGGI 4T contains a library with the gamma data of 30 elements. Some sample cases are described, and part of their results is compared with those of other authors. (auth)

5396 (K-DP-2623) SOME CHARACTERISTICS OF SECONDARY GAMMA RAY TRANSPORT IN ASYMMETRIC SNAP SHIELDS. Mynatt, F. R. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). [nd]. Contract W-7405-eng-26. 8p. Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

The discrete ordinates method for calculations of neutron and gamma transport and the tools required for its use (one- and two-dimensional transport codes, multigroup gamma cross sections, and coupling techniques) are described briefly. Two one-dimensional calculations are presented: one for a pure tungsten slab 100 cm thick, and the other for a 5-ft concrete slab with a fairly complex source at the left interface from which the most numerous source neutrons were directed almost parallel to the surface in the 5- to 6-MeV group. A two-dimensional calculation for the shield assembly for a ZrH-moderated SNAP reactor is discussed, and results are shown in figures. The shield is composed of two W zones and two LiH zones. It is concluded that the discrete ordinates method is a reasonable and effective tool for gamma transport in both extreme straightforward penetration problems and those involving unusual scattering situations. (A.G.W.)

5397 (NP-17030) UNTERSUCHUNGEN UEBER DIE ABSCHIRMUNGEN IN DER WIEDERAUFARBEITUNGSANLAGE FUER BESTRAHLTE KERNBRENNSTOFFE KARLSRUHE (WAK). (Investigations on the Shielding in the Reprocessing Installation for Irradiated Nuclear Fuels at Karlsruhe (WAK)). Futtermenger, W.; Schultz, H. (Technische Hochschule, Hanover (West Germany). Arbeitsgruppe fuer Bautechnischen Strahlenschutz). Dec. 1966. 139p. (In German). Dep.

The principles for the calculation of shielding in fission-product processing installations are given. The basic data used in shielding calculation are summarized and the numerical calculation methods are described. The calculation accuracy is analyzed. The principles and methods are applied to an evaluation of the shielding necessary in the WAK. The most important units of the reprocessing installation are shown graphically. (J.S.R.)

5398 (ORNL-RSIC-11(Rev.1)) BIBLIOGRAPHY, SUBJECT INDEX, AND AUTHOR INDEX OF THE LITERATURE EXAMINED BY THE RADIATION SHIELDING INFORMATION CENTER (SPACE AND ACCELERATOR SHIELDING). Gurney, J. (ed.) (Oak Ridge National Lab., Tenn.). Sept. 1967. 107p. Dep. CFSTI.

A listing is presented of approximately 400 articles on space radiation sources, cross section data, particle transport, and shielding. (M.O.W.)

5399 CALCULATING DOSE DERIVATIVES BY THE MONTE CARLO METHOD IN ORDER TO OPTIMIZE THE FORM AND COMPOSITION OF RADIATION SHIELDING. Brainina, M. Z.; Generozov, V. L.; Kuznetsov, V. G.; Sakovich, V. A. Zh. Vychisl. Mat. Mat. Fiz., 7: 953-7(July-Aug. 1967). (In Russian).

The Monte Carlo method is advantageous in calculating the dose passing through a substance, when the shield has a complicated form and structure. A search for the optimal form and composition of a shield of minimum weight can be carried by a variational method of calculation, if the analytical relation between the dose and variable shield parameters is known. Gradient programming simplifies the problem, since only the first derivatives of the dose with respect to the shield parameters need be known at each step of the optimization iterative process. It would be convenient to calculate these dose derivates by a Monte Carlo method simultaneously with calculation of the dose. A method of doing so is presented in the text. (TTT)

5400 PHOTON ATTENUATION AND ENERGY-ABSORPTION COEFFICIENTS: CURRENT STATUS AND PROSPECTS. Hubbell, J. H. (National Bureau of Standards, Washington, D. C.). Trans. Amer. Nucl. Soc., 10: 542(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5401 APPLICATION OF SPINNEY'S METHOD TO SECONDARY GAMMA-RAY CALCULATIONS. Greenborg, J. Trans. Amer. Nucl. Soc., 10: 542(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5402 SOME CHARACTERISTICS OF SECONDARY GAMMA-RAY TRANSPORT IN ASYMMETRIC SNAP SHIELDS. Mynatt, F. R. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 542(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5403 SECONDARY GAMMA-RAY PRODUCTION: COMPARISON OF THEORY AND EXPERIMENT. Western, G. T. (General Dynamics, Fort Worth, Tex.). Trans. Amer. Nucl. Soc., 10: 542-3(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5404 INVESTIGATION OF PROCEDURES FOR DETERMINATION OF BUILDUP FACTORS IN TWO-LAYERED SHIELDS. Chatterton, M. S.; Barkley, B. L.; Deutsch, R. W. (Catholic Univ. of America, Washington, D. C.). Trans. Amer. Nucl. Soc., 10: 543-4(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5405 HIGH-ORDER TRANSPORT RESULTS FOR GAMMA RAYS IN MULTILAMINAR GEOMETRY. Lois, L. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 544-5(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5406 OPTIMIZATION OF A MAGNETIC RADIATION SHIELD. Manuilov, V. G. Zh. Tekh. Fiz., 37: 1230-2(July 1967). (In Russian).

The shielding of a space vehicle from cosmic rays by means of a toroidal magnetic field with transverse symmetry is discussed. A first integral of the relativistic equations of motion of a charged particle in the shielding field is obtained and the maximum depth of penetration into the field of cosmic-ray particles with a given rigidity is calculated. The results of this calculation are presented graphically. As an example, it is shown that a 6 m diameter cylindrical vehicle can be shielded from 900-MeV protons by means of a magnetic field having the discussed configuration and a maximum strength of 10^5 gauss (the critical field for superconducting Nb_3Sn) provided the shielding field is 1.14-m thick. (ATD)

5407 METOD MONTE-KARLO V PROBLEME PERENOSA IZLUCHENII. (Monte-Carlo Method for Calculating Radiation Transmission). Marchuk, G. I. (ed.). Moscow, Atomizdat, 1967. 256p.

The Monte Carlo method represents a statistical method used in the solution of problems, including a series of random events. This method at the present is one of those generally used for the solution of problems of radiation transmission in the presence of complex geometry, anisotropic scattering processes, and energy dependence of the cross section. Methods developed in the last decade for the augmentation of the statistical efficiency of methods makes it possible to calculate a series of problems in the theory of radiation transmission. Methodic questions on the utilization of the Monte Carlo method in the solution of radiation transmission problems were examined. Precise numerical results on problems in the nuclear field are given. Sixteen papers are included. (tr-auth)

Solid-State Physics

Refer also to abstracts 4465, 4528, 4814, 4815, 4845, 4904, 5024, 5779, 5791, 5866, and 5875.

5408 (IFA-FN-29) LOW-FREQUENCY MOTIONS IN SOLID BENZENE BY INELASTIC SCATTERING OF COLD NEUTRONS. Tarina, V. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). Aug. 4, 1966. 5p. Dep.

The results obtained by inelastic scattering of cold neutrons on solid benzene in the temperature range from 77 to 298°K are given. The cold neutron facility consisted of Be filter, chopper with bent slits, and a 400-channel analyzer. The calculated mean energy of incoming neutrons was 4.18 MeV. The benzene sample of 0.4 mm thickness was cooled by a flow of cold gas boiled off from liquid nitrogen. The corrected scattered-neutron spectra for a scattering angle of 45° and six temperatures are shown. (W.D.M.)

5409 (IS-T-185) THERMAL CONDUCTIVITY OF DYSPROSIUM, ERBIUM, AND LUTETIUM SINGLE CRYSTALS. Boys, Donald Waring (Ames Lab., Iowa). Nov. 1967. Contract W-7405-eng-82. 80p. Dep. CFSTI.

Thesis.

The thermal conductivity of dysprosium, erbium, and lutetium single crystals has been measured as a function of temperature from 5 to 300°K. The measurements were made by the steady-state heat flow method. The electrical resistivity of these same crystals was also measured so that the Lorenz function could be calculated. The thermal conductivity of each element was measured along the ⟨0001⟩ (c-axis) direction and along a basal plane direction. The magnetic transitions in dysprosium and erbium produced a pronounced effect on the c-axis thermal conductivity. A precipitous drop occurred at the ferromagnetic–antiferromagnetic transition. A sharp rise occurred as the antiferromagnetic–paramagnetic transition was approached. Only slight effects were noticeable in the basal plane measurements. This has been interpreted on the basis of magnetic superzone energy gaps. The thermal conductivity of nonmagnetic lutetium showed a temperature dependence similar to the non-rare-earth metals. The calculated Lorenz functions were considerably larger than expected for pure electron heat transport in all cases except the c-axis lutetium crystal. This suggested that magnons and phonons contribute significantly to the heat flow. In the paramagnetic temperature region considerable anisotropy exists between the basal plane and c-axis thermal conductivity. This is interpreted in terms of the anisotropic Fermi surfaces of the rare earths. Above the Debye temperature the thermal conductivity consists of phonon and electron contributions. (auth)

5410 (IS-T-187) OPTICAL PROPERTIES OF DILUTE SILVER–INDIUM ALLOYS IN THE ULTRAVIOLET. Morgan, Relbue Marvin (Ames Lab., Iowa). Nov. 1967. Contract W-7405-eng-82. 103p. Dep. CFSTI.

Thesis.

The optical constants of silver and five dilute silver–indium alloys were determined from reflectance and transmittance measurements in the spectral region between 3.35 and 4.28 eV on vacuum-evaporated films. The concentrations ranged from 0.5% to 4.1% indium, and the film thicknesses ranged between 1000 and 1600 Å. On the assumption that the onset of interband absorption in silver is due primarily to direct interband transitions from the d band near L_3 to the Fermi surface, but with a small, though not insignificant, contribution due to direct transitions from the conduction band near L_2' to the conduction band near L_1, the changes induced by alloying in the complex dielectric constant were interpreted to indicate a shift of the $L_3 \rightarrow F_7$ transition to higher energy and a shift of the $L_2' \rightarrow L_1$ transition to lower energy. Because contributions to the dielectric constant of the two transitions overlap and because of the limited energy range investigated, no firm estimates of the magnitudes of the shifts could be made. The strength of the interband absorption in the alloys at low energies (energies below the onset in silver) appeared to be too strong to be accounted for by indirect transitions. Alloying-induced changes in the energy-loss function showed that the relatively undamped plasma resonance in silver near 3.8 eV becomes strongly damped as indium is added. The increase in damping was attributed partly to a decrease in the conduction electron relaxation time and partly to the shift of interband transitions so that they occur at the plasma energy. Data from measurements on films cooled to liquid helium temperature showed some sharpening of structure in the complex dielectric constant and of the peak in the loss function. The changes produced by cooling became increasingly subtle with increasing indium concentration. (auth)

5411 (IS-T-198) PIEZORESISTANCE OF N-TYPE MAGNESIUM STANNIDE. Crossman, Leon Duane (Ames Lab., Iowa). Nov. 1967. Contract W-7405-eng-82. 144p. Dep. CFSTI.

Thesis.

The piezoresistance tensor components for n-type Mg_2Sn have been measured from 50 to 300°K. The piezoresistance effect in Mg_2Sn is larger than the piezoresistance effect in germanium or silicon. From these measurements and the elastic constants of Davis et al., the elastoresistance tensor components were obtained and found to satisfy $m_{11} = -2m_{12}$, m_{11} large and m_{44} small, in the temperature range 50 to 200°K. These relationships confirm that n-type Mg_2Sn is a many-valley semiconductor with constant energy ellipsoids in the ⟨100⟩ direction. The fact that m_{11} and m_{12} were both linear in the temperature range 60 to 175°K indicates that intervalley scattering is unimportant in the extrinsic temperature region. The small value of the volume coefficient, $(m_{11} + 2m_{12})/3$, indicates that carrier mobility in n-type Mg_2Sn is relatively insensitive to changes in sample volume. The deformation potential was determined from a combination of these piezoresistance results and Umeda's magnetoresistance data and found to satisfy the relation $\Xi_u = \Xi_u^0(1 + \alpha T)$, where $\Xi_u^0 = 10.1$ eV and $\alpha = (-4.3 \pm 0.6) \times 10^{-4}$ °K^{-1}. High stress piezoresistance measurements yielded a deformation potential of $\Xi_u = 18$ eV and mobility anisotropy of K = 2.65 at 77.4°K. Umeda obtained K = 3.51. A possible qualitative explanation of these differences can be given in terms of a change with stress of the position of the donor levels with respect to the conduction band. (auth)

5412 (IS-T-203) ANALYSIS OF ELECTRON SPIN RESONANCE SPECTRA OF THE GADOLINIUM ION IN SODA SILICA GLASSES. Nicklin, Robert Clair (Ames Lab., Iowa). Nov. 1967. Contract W-7405-eng-82. 121p. Dep. CFSTI.

Thesis.

The electron spin resonance of the Gd^{3+} ion was studied in two series of glasses having the molar compositions $6SiO_2 : 5Na_2O : x(Gd_2O_3 + Y_2O_3)$ with $0 \leq x \leq 0.5$ and $500SiO_2 : xNa_2O : 1Gd_2O_3$ with $2.5 \leq x \leq 494$. The spectra were nearly independent of temperature and sample composition, but varied strongly with microwave frequency in the range 5.4 to 38.4 GHz. Saturation and relaxation effects were noted at 9.8 GHz. (auth)

5413 (IS-T-206) LATTICE DYNAMICS OF SOLID HELIUM. Morley, Gayle L. (Ames Lab., Iowa). Nov. 1967. Contract W-7405-eng-82. 134p. Dep. CFSTI.

Thesis.

Numerical calculations of the vibrational properties of solid helium have been carried out for the hcp phase of solid ^3He and

^{4}He at 0°K. The harmonic coupling parameters for first and second neighbors have been evaluated for four molar volumes in the range 10.0 to 16.0 cm^3 using the harmonic ground-state wave function and the self-consistent method of Koehler. The dispersion relations and sound velocities were evaluated in the symmetry directions Σ, T, and Δ. The frequency distribution functions and Debye temperatures at 0°K have also been obtained for both solids in the hcp phase. A comparison with experiment indicates that the calculated Debye temperatures are too high; the agreement with experiment is best at the highest density examined. The value of θ_3/θ_4 at 0°K is found to be 1.23 as compared with the classical value of 1.154 and the experimental value of 1.18. (auth)

5414 (JUL-496-NP) ZUR GITTERTHEORIE VON FESTEM HELIUM UND ANDERN VAN-DER-WAALS-KRISTALLEN AUS LEICHTEN ATOMEN. (The Lattice Theory of Solid He and Other van-der-Waals Crystal of Light Atoms). Biem, Walter (Kernforschungsanlage, Juelich (West Germany). Institut fuer Neutronenphysik). July 1967. 62p. (In German). Dep.

Thesis. Submitted to Technische Hochschule, Aachen.

The Nosanow theory of quantum crystals, which calculates the ground state of solid ^{3}He and ^{4}He, is outlined. This theory is the starting point for a lattice theory of Van der Waals crystals. The theory of lattices, whose atoms have a wide zero point oscillation and in which the potential between the atoms has however no hard core, is then considered. The theory is put in a form which makes its affinity with known lattice theory easily detectable and can be applied as perturbation theory. The method is a simplified random-phase approximation. The lattice theory for crystals in which the hard core of the interaction potentials must be considered is then considered. (J.S.R.)

5415 (LA-3773) LATTICE DYNAMICS OF BISMUTH. Smith, Darryl B. (Los Alamos Scientific Lab., N. Mex.). June 1967. Contract W-7405-eng-36. 101p. Dep. CFSTI.

Dispersion curves for phonons propagating in the binary and ΓX directions in bismuth at 75°K have been measured by inelastic neutron scattering. A group theoretical analysis of modes of vibration in the bismuth lattice has been made. The results were used to label the branches of the dispersion relation, and to reduce the dynamical matrices for phonon propagation in the trigonal, binary, and ΓX directions to block diagonal form. Both a second-neighbor general Born–von Karman force model and this model augmented by the inclusion of axially symmetric third- and fourth-neighbor force constants were constructed and were fitted to the present data and to previous data for the trigonal direction. Although the second of these models reproduced the general features of the data, it was concluded that forces due to atoms beyond fourth-nearest neighbors are required to fit the data within the experimental errors. The phonon frequencies at the symmetry points X and L in the Brillouin zone were used along with a recent measurement of the electron–hole recombination time in bismuth to determine the location of the valence band maxima. The data favor these maxima being at the points T in the Brillouin zone. (auth)

5416 (NP-17117) DIVISION OF PHYSICS ANNUAL REPORT, 1966–1967. (National Standards Lab., Sydney (Australia). Div. of Physics). 39p. Dep.

Brief summaries are given on research being carried out in the fields of temperature measurement, solid-state physics, fluid physics, optics, optical radiometry, solar physics, and resistance standards. (W.D.M.)

5417 (NP-17130) BIBLIOGRAPHY ON THE HIGH TEMPERATURE CHEMISTRY AND PHYSICS OF GASES AND PLASMAS. No. 24. Brewer, L. (comp.) (California Univ., Berkeley. International Union of Pure and Applied Chemistry. Commission on High Temperature and Refractories). Sept. 30, 1967. 21p. NBS, Washington, D. C. Free.

Two hundred references on spectroscopy of interest to high-temperature chemistry and on reactions between gases and condensed phases are listed. (A.G.W.)

5418 (NP-17141) BIBLIOGRAPHY ON THE HIGH-TEMPERATURE CHEMISTRY AND PHYSICS OF MATERIALS IN THE CONDENSED STATE. Volume 1967, Number 3, July–September 1967. Diamond, J. J. (ed.) (National Bureau of Standards, Washington, D. C. International Union of Pure and Applied Chemistry. Commission on High Temperatures and Refractories). 73p. NBS, Washington, D. C. Free.

The 781 references included are grouped under the following section headings: devices for achieving temperatures above 1500°C; devices for measuring and controlling temperatures above 1500°C; devices for physical measurements at temperatures above 1000°C; properties, at temperatures below 1000°C, of materials which melt above 1500°C; properties, at temperatures above 1000°C, of materials which melt above 1500°C; properties, at temperatures above 1000°C, of materials which melt below 1500°C; phase equilibria; reactions at temperatures above 1000°C; and books. (A.G.W.)

5419 (NYO-2391-24) DYNAMICS AND THERMAL PROPERTIES OF ONE AND THREE DIMENSIONAL MOLECULAR MODELS OF Li DEFECTS IN KCl. Gomez-Rodriguez, M.; Krumhansl, J. A.; Matthew, J. A. D. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Feb. 1966. Contract AT(30-1)-2391. 37p. Dep. CFSTI.

Recent experiments in KCl containing Li^+ as an impurity have revealed properties uncharacteristic of monovalent substitutions. The behavior of Li^+ in KCl resembles that of dipolar ions such as OH^- and CN^- in host materials rather than that of other monovalent substitutions. Models which show these features of the Li:KCl system are examined. Essentially, these consider the Li^+ as a hard sphere moving in a multiple-well harmonic oscillator potential. The parameters are adjusted in such a way as to reproduce a tunnel splitting of about 1 cm^{-1}. Both a one- and a three-dimensional model are discussed. To obtain approximate energies and wave functions for the model, linear combinations of the ground state wave functions were used as in the LCAO approximation. Finally the specific heat, polarizability, and dipole moment were obtained and found to be consistent with experimental results. The one-dimensional model is discussed first to present the essential steps in the calculation and establish the orders of magnitude of the parameters involved in the problem. The more realistic three-dimensional system is discussed next. With the help of group theory, all possible locations of the potential wells consistent with the symmetry of the crystal are discussed, and the possibility of nonspherical wells is considered. (M.H.R.)

5420 (NYO-3842-1) RADIATION-INDUCED DEFECTS IN ALKALI HALIDES, AND THEIR ROLE IN RECOMBINATION PROCESSES. Progress Report, March 1, 1967–February 29, 1968. Murray, R. B. (Delaware Univ., Newark. Dept. of Physics). Nov. 20, 1967. Contract AT(30-1)-3842. 7p. Dep. CFSTI.

Equipment has been procured and installed in the laboratory. Experiments on the Pooley–Hersh mechanism in KBr(Tl) are planned. Experiments on the V_k center in KCl were performed to determine whether reorientation in an electronic excited state exhibits a correlation between initial and final position similar to that observed in thermally excited reorientation. The results are summarized. Experiments were initiated to look for $(e^- + V_k)$ luminescence in LiF. Work is in progress on identification of V_k absorption and $(e^- + V_k)$ luminescence in NaCl. (M.H.R.)

5421 (PRNC-106) F CENTER FORMATION AT 78°K IN KBr DURING EXPOSURE TO MONOCHROMATIC X-RAY ENERGIES AROUND THE BROMINE K EDGE. Cruz Vidal, Baltasar A. (Puerto Rico Nuclear Center, San Juan). May 1967. Contract AT(40-1)-1833. 124p. Dep. CFSTI.

Thesis. Submitted to Harvard Univ., Cambridge, Mass.

In KBr irradiated at 78°K the rate of formation of F centers per unit energy retained in the crystal was found to be the same whether 13.4 keV or 14.1 keV was the incident photon energy (the K edge of bromine is at 13.5 keV). In other words, at either incident photon energy the energy expenditure per F center formed was 1.21×10^3 eV ± 4.4%. This result indicates that K-shell ionization in bromine does not affect the mechanism of formation of F centers in KBr. However, a large background of multiply ionized atoms is expected whether the incident photon energy is 13.4 keV or 14.1 keV. Each of these atoms becomes multiply ionized after losing an electron in the L shell. Thus, in a bromide the equality of the rate of formation of F centers above and below the K edge is not sufficient evidence to conclude that a Varley mechanism of F center formation is not operative. Each of the monochromatic beams was the fluorescent output of RbCl filtered with a thin layer of NaBr or of $Sr(NO_3)_2$ filtered with RbCl. The output of a Machlett X-Ray Tube operated at 45 kVp was used to excite the fluorescence. The current in the tube was regulated to achieve the same energy flux on the sample regardless of the incident photon energy. An air ionization chamber was calibrated with a calorimeter and was used to measure the flux. The half-width of each monochromatic beam was 330 eV. Measurements of the energy expenditure required to form one F center follow: for KCl irradiated at 78°K, 6.9×10^2 eV ± 4.2%; for KBr irradiated at 300°K, 4.8×10^3 eV ± 5.7%; for RbBr at 78°K, 1.2×10^3 eV ± 17%; and for RbBr at 300°K, 1.3×10^3 eV ± 30%. (auth)

5422 (ANL-Trans-536) APPROXIMATE EQUATION OF STATE OF SOLIDS. Koryavov, V. P. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 123-6(Sept.-Oct. 1964). 10p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The correctness of the Mie–Grüneisen equation for solids is as-

sumed in this communication which deals with a simple approximation of functions which enter this equation by means of known shock adiabats. These functions can be used, in particular, for the description of the state of substances compressed in strong shock waves. (W.D.M.)

5423 INHOMOGENEOUS DYNAMICAL NUCLEAR ORIENTATION IN THE PHONON THERMAL CONDUCTIVITY OF THE PARAMAGNETIC CRYSTALS. Iolin, E. M. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 4, 35-42(1967). (In Russian).

It is shown, that dynamical nuclear orientation exists in the phonon thermal conductivity of the paramagnetic crystals and is inhomogeneous in space and may be compared with nuclear orientation in the thermal equilibrium. The transfer equation is considered in the case with or without spectral diffusion and in the case of diffusion or mirror reflection of phonons from the crystal's surface. (tr-auth)

5424 CRYSTAL FIELD IN RARE-EARTH TRICHLORIDES. II. EXCHANGE CHARGE EFFECTS IN $PrCl_3$. Bishton, S. S.; Ellis, M. M.; Newman, D. J.; Smith, J. (Queen Mary Coll., London). J. Chem. Phys., 47: 4133-6(Nov. 15, 1967).

The redistribution of charge due to overlap between the rare-earth ion $5s^2p^6$ shell and the surrounding ligands and to overlap between neighboring ligands is shown to produce a large reduction in the electrostatic contributions to the crystal field. This correction brings the calculated value of $A_2^0\langle r^2\rangle$ close to its experimental value in $PrCl_3$. (auth)

5425 RELATION BETWEEN THE ELECTRONIC STRUCTURE OF TIN IN ITS COMPOUNDS AND THE ISOMER SHIFTS IN MOESSBAUER SPECTRA. Goldanskii, V. I.; Makarov, E. F.; Stukan, R. A. (Inst. of Chemical Physics, Moscow). J. Chem. Phys., 47: 4048-52(Nov. 15, 1967).

Expressions relating isomer shifts in Mössbauer spectra with the electronic structure of tin in its compounds are obtained. These expressions give a description of isomer shifts for chemical compounds of different types: tetravalent tin when there is π bonding (tin tetrahalogenides), tetravalent tin in the absence of π bonding (compounds where tin is bound with alkyl, aryl, and carbonyl metal radicals), bivalent tin, etc. The expressions obtained were used for analysis of the electronic structure of tin in compounds of these classes. For tetravalent tin compounds with π bonding the change of isomer shift δ towards negative values (with respect to α-Sn) is found to be accounted for by a decrease, and for compounds without π bonds by an increase in the number of valence 5s electrons (S) at $S > 1$. (auth)

5426 ABSORPTION AND EMISSION SPECTRA OF Er^{3+} IN Sc_2O_3. Pirinchieva, R. K. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 49-52(July 1967).

Translated from Opt. Spektrosk., 23: 96-101(July 1967).

The absorption and emission spectra in the visible region of the Er^{3+} in Sc_2O_3 were investigated. The positions of the Stark components of the ground level $^4I_{15/2}$ and of the sublevels of the excited levels of the Er^{3+} between 18,200 and 26,500 cm^{-1} are calculated on the basis of these spectra. The temperature dependencies of the integral intensities and of the half-widths of the emission lines of the $^4S_{3/2} \rightarrow {}^4I_{13/2}$ group are investigated. (auth)

5427 DEFECT STRUCTURE OF γ-IRRADIATED ZINC OXIDE SINGLE CRYSTAL. Chandra, Prafulla; Tare, V. B.; Sinha, A. P. B. (National Chemical Lab., Poona). Indian J. Pure Appl. Phys., 5: 271-4(July 1967).

Single crystals of zinc oxide have been irradiated in air at 25°, 100° and 300°C by γ rays from a ^{60}Co source. The resistance first increases with irradiation time, reaches a maximum after about 5 hr, then decreases slightly and finally attains a constant value. At 100°C, the maximum in the resistance appears earlier and at 300°C it vanishes completely. This behavior has been attributed to the change from n-type to p-type conduction due to the adsorption of oxygen. The effect of ambient atmospheres has also been studied. In nitrogen atmosphere ($p_{O_2} \simeq 10^{-3}$ atm), the resistance decreases with irradiation time, which supports the above conclusion. When the crystal is irradiated in the presence of hydrogen, resistance initially decreases, then starts increasing again, and finally becomes constant. This has been attributed to the reduction and subsequent precipitation of zinc as a separate phase. (auth)

5428 A PRECISION MEASUREMENT OF THE RATIO OF THE PROTON NMR FREQUENCY TO THE CYCLOTRON FREQUENCY OF FREE ELECTRONS IN THE SAME MAGNETIC FIELD. Klein, E. (Freie Univ., Berlin). Z. Phys., 208: 28-59(1968). (In German).

A new precision measurement of the ratio of the proton NMR frequency to the cyclotron frequency of free electrons in the same magnetic field, $\omega_p/\omega_e = \gamma_p mc/e$, has been performed. A cyclotron resonance linewidth of 5 ppM only and a reduction of the large space charge shifts, up to the order of 50 ppM in earlier published measurements, enabled a high accuracy. The final result is $\omega_p/\omega_e = 1.5209945 \times 10^{-3} \pm 0.5$ ppM, where the NMR is referred to a long cylindrical sample of H_2O, 0.2M $CuSO_4$. Corrected to the free proton, the result is $\omega_p/\omega_e = 1.5210329 \times 10^{-3} \pm 0.6$ ppM. Combination of this result with an EPR measurement of Lambe yields a free-electron g factor of $g = 2(1 + (\alpha/2\pi) - (0.30 \pm 0.09)(\alpha/\pi)^2)$ in good agreement with the theoretical value $g = 2(1 + (\alpha/2\pi) - 0.328(\alpha/\pi)^2 \pm \ldots)$. (auth)

5429 PULSED NUCLEAR MAGNETIC RESONANCE STUDY OF IRRADIATED LITHIUM HYDRIDE. Souers, P. C.; Jolly, T. A.; Cline, C. F. (Univ. of California, Livermore). J. Phys. Chem. Solids, 28: 1717-19(Sept. 1967).

Lithium hydride doped with ^3H expands by a self-damaging process. Samples stored at 23, 70, 125, and 250° were studied at 23° by pulsed nuclear magnetic resonance. Motionally narrowed signals were found for ^1H, ^3H, ^7Li, and ^3He. The numbers of nuclear spins in these signals were measured and compared with the fractional volumetric increase of the LiH. The intensity of ^1H and ^3H signals correlated with the initial swelling up to a growth of 25 to 30 volume percent. The buildup of ^3He probably causes later stage growth. Lithium metal precipitation increases with increasing temperature. The form of the free hydrogen in the lower-temperature samples is unknown. In the 250° sample the transverse relaxation time (T_2) was approximately equal to the spin–lattice relaxation time (T_1), which is normally observed for hydrogen gas. (auth) (UK)

5430 HELICON WAVES IN SOLIDS. Morgan, D. P. (University Coll., London). Phys. Status Solidi, 24: 9-36(Nov. 1, 1967).

A study is made of electromagnetic wave propagation in the low-frequency limit in an uncompensated solid-state plasma. The conditions for helicon propagation are described. Phenomena occurring in the local case (helicon–phonon interaction and open–orbit effects) and the nonlocal case (Doppler-shifted cyclotron absorption) are considered. (D.L.C.)

5431 STUDY OF ALNICO 8 BY MOESSBAUER SPECTROSCOPY. Makarov, E. F. (Inst. of Chemical Physics, Moscow); Povitskii, V. A.; Granovskii, E. B.; Fridman, A. A. Phys. Status Solidi, 24: 45-50(Nov. 1, 1967).

The hard magnetic alloy "alnico 8" was investigated by Mössbauer spectroscopy. Two nonequivalent positions are found for the Fe atoms in the hardened alloy. After tempering and a magnetic-field heat treatment cycle (MFT) some of the Fe atoms are found to have a paramagnetic environment. The MFT has the effect of increasing the fraction of the Fe atoms which have such an environment and a maximum value of 7% is obtained for this fraction. The magnetic fields at the ^{57}Fe nuclei are determined for various states of the alloy. The results are discussed together with the results of Mössbauer investigations of "alnico 5." (auth)

5432 MAGNETIC DETECTION OF HALL CURRENTS. Milliard, J.; Lassere, P.; Fortini, A. (Univ., Caen, France). Rev. Phys. Appl., Suppl. J. Phys., 2: 213-17(Sept. 1967). (In French).

The magnetic field generated by Hall currents in Corbino disk geometry is studied. A mounting which permits field measurement in the disk center is described. The resulting data with indium antimonide are in good agreement with theoretical calculations. This mounting could permit magnetic field amplification using high mobility semiconductors, if effects such as hot electrons do not limit mobility in high fields. (auth)

5433 THE NEEL TEMPERATURES AND STABILITY OF MAGNETIC PHASES IN THE DISTURBED BODY-CENTERED TETRAGONAL LATTICE, URANIUM COMPOUNDS. Przystawa, J. (Univ. of Wroclaw). Phys. Status Solidi, 24: 313-22 (Nov. 1, 1967).

The RPA Green's function method is used to treat the stability of various antiferromagnetic structures, as observed in a number of uranium compounds, on the basis of Heisenberg exchange interactions between first, second, and third neighbors. It is shown that these interactions cannot be neglected in a disturbed body-centered tetragonal lattice. Expressions for the Néel temperatures are given given and calculated explicitly. These results are compared with molecular field theory and it is shown that the latter correctly determines the range of exchange parameters which is admissible for the stable phase. (auth)

5434 MAGNETIC PROPERTIES OF SOME RARE EARTH HEXABORIDES. Paderno, Yu. B.; Pokrzywnicki, S.; Stalinski, B. (Inst. of Low Temperature and Structural Research, Wroclaw). Phys. Status Solidi, 24: K73-6(Nov. 1, 1967).

The magnetic susceptibilities of the hexaborides of La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, and Yb were measured between 80 and 300°K. The classes of differing magnetic behavior in which the borides fall are discussed. The anomalous behavior of SmB_6 and CeB_6 is considered in some detail. (D.L.C.)

5435 MAGNETIC PROPERTIES OF SOME HEAVY RARE EARTH TETRABORIDES. Paderno, Yu. B.; Pokrzywnicki, S. (Inst. of Low Temperature and Structural Research, Wroclaw). Phys. Status Solidi, 24: K11-12(Nov. 1, 1967).

The magnetic susceptibilities of GdB_4, DyB_4, HoB_4, ErB_4, and TmB_4 were measured between 82 and 300°K. The results follow the Curie–Weiss law, with the effective magnetic moments close to those expected for the tervalent rare earth ions. No magnetic transitions were found. (D.L.C.)

5436 ELECTRONIC STRUCTURE OF RARE-EARTH SESQUISULFIDE CRYSTALS. Henderson, J. R. (Douglas Aircraft Co., Santa Monica, Calif.); Muramoto, M.; Loh, E.; Gruber, John B. J. Chem. Phys., 47: 3347-56(Nov. 1, 1967).

Single crystals of R_2S_3, R = Dy, Gd, Nd, and Y, have been grown by flame fusion in an argon plasma torch and by the Bridgman technique. The purification of R_2O_3 starting materials, synthesis and analysis of compound powders R_2S_3, crystal growth, analysis to determine if single crystals are produced, and measurement of electrical resistivity and thermoelectric power coefficient from 300° to 1300°K are discussed. The electrical measurements indicate highly degenerate semiconductor behavior with ρ and α increasing with temperature in contrast with previous reports for rare-earth tellurides and selenides. The presence of the rare-earth ions in their trivalent state and the absence of divalent ions have been confirmed independently by reflectance spectra from powders, by absorption spectra of single crystals, and by measurement of magnetic susceptibility of single crystals. The materials are unusual because they are semiconductors with the $(4f)^n$ levels of the rare-earth ions spanning the bandgap in ladder-like fashion. The free-ion energy levels of Dy^{3+} were obtained by diagonalization of the electrostatic and spin–orbit matrices arising from a perturbation calculation, and least-squares fitting of the calculated levels to experimental values. The Dy_2S_3 spectra are correlated with DyF_3 and Dy_2O_3 results. (auth)

5437 MAGNETIC MOMENT OF $ZrZn_2$ UP TO 150 kG: IS "PURE" $ZrZn_2$ FERROMAGNETIC? Foner, S.; McNiff, E. J. Jr.; Sadagopan, V. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 19: 1233-6(Nov. 20, 1967).

Magnetic-moment measurements in polycrystalline and single-crystal $ZrZn_2$ for fields to 150 kG are presented. The high-field susceptibility is identical for all materials, whereas the low-field moment varies over a wide range. The data indicate that the low-field moment is correlated with trace impurities (such as Fe and Ti) and details of preparation. A localized-moment model for ferromagnetism in impure $ZrZn_2$ is suggested, which is consistent with the results; but it is not yet clear whether or not "pure" $ZrZn_2$ is ferromagnetic. (auth)

5438 DIFFRACTION CONTRAST FROM γ-PHASE PRECIPITATES FORMED IN THE LATE STAGES OF DECOMPOSITION OF THE SOLID SOLUTION Cu-2 PERCENT Be. Sorokin, L. M. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 9: 1353-9(Dec. 1967).

Translated from Fiz. Tverd. Tela, 9: 1723-31(June 1967).

Some contrast effects in the electron-microscope images of thin foils of Cu–2% Be alloy containing γ-phase precipitates are discussed. It is shown that in the case of precipitates which extend through the whole thickness of the foil and lie in the reflecting position at the same time as the matrix, the contrast of the precipitates can be accounted for by the difference in structural factors of the respective reflections of the matrix and the precipitate. Dislocations were observed at the interphase boundary. The origin of moiré bands on the precipitate images is discussed. (auth)

5439 INFLUENCE OF THE CRYSTAL FIELD ON ANGULAR γ–γ CORRELATION IN PARAMAGNETS. Khaimovich, F. P. (Physical Technical Inst., Kazan). Sov. Phys.-Solid State (Engl. Transl.), 9: 1261-4(Dec. 1967).

Translated from Fiz. Tverd. Tela, 9: 1603-8(June 1967).

Equations are obtained for the attenuation of γ-quanta correlation in paramagnets, allowing for the effect of the crystal field. Detailed calculations are carried out for three typical rare-earth ions from room temperature down to liquid-helium temperatures. It is shown that the change in the correlation is especially pronounced below liquid-nitrogen temperatures. Possible experiments for observing the angular correlation with a simultaneous change in the population of the Zeeman levels by the method of electron paramagnetic resonance are examined. (auth)

5440 A LATTICE-DYNAMICAL INVESTIGATION OF THE HYDRIDES CeH_2, CeH_3, ThH_2, AND $UH_{2.7}$ USING INELASTIC SCATTERING OF COLD NEUTRONS. Karimov, I.; Zemlyanov, M. G.; Kost, M. E.; Somenkov, V. A.; Chernoplekov, N. A. Sov. Phys.-Solid State (Engl. Transl.), 9: 1366-8(Dec. 1967).

Translated from Fiz. Tverd. Tela, 9: 1740-3(June 1967).

Inelastic scattering of cold neutrons from samples of the hydrides CeH_2, CeH_3, ThH_2, and $UH_{2.7}$ was studied. From the results of the investigation, the distribution functions for the square of the atomic displacements from their equilibrium positions due to thermal excitation for the lattices of these hydrides was established and the energies of the singularities of these functions was located. (auth)

5441 CAPTURE OF HOLES BY Tl^+ CENTERS IN KI:Tl. Kink, R. A.; Liid'ya, G. G. (Inst. of Physics and Electronics, Tartu). Sov. Phys.-Solid State (Engl. Transl.), 9: 1316-19 (Dec. 1967).

Translated from Fiz. Tverd. Tela, 9: 1674-8(June 1967).

Hole color centers, associated with the activator, were formed in KI:Tl crystals by irradiation with x rays. These centers had absorption bands at 3.4, 2.8, 2.2, and 1.6 eV. The thermal and optical liberation of holes from the corresponding capture levels was investigated. It is suggested that holes are localized at the 6s level of the thallium ion at a regular lattice site, and that the excitation of a center transfers an electron from a neighboring anion to Tl^{2+}. (auth)

5442 COMBINATORIAL METHOD FOR CALCULATING THE MOESSBAUER HYPERFINE SPECTRUM. Karyagin, S. V. (Inst. of Chemical Physics, Moscow). Sov. Phys.-Solid State (Engl. Transl.), 9: 1252-4(Dec. 1967).

Translated from Fiz. Tverd. Tela, 9: 1590-3(June 1967).

A method is presented for determining the hyperfine structure (hfs) sublevels of Moessbauer spectra where the local field is strongly nonaxial and splits a nuclear level with spin j into 2j + 1 nonequidistant sublevels. In these cases the usual methods of calculation are unsuitable due to the absence of any symmetry in the spectrum either in the intensities or in the positions of the hfs components. The method permits a quite simple computation of the spectrum with an arbitrary nuclear spins in both the excited and the ground states. (auth)

5443 INFLUENCE OF IONIZING RADIATION ON THE ELECTRICAL AND PARAMAGNETIC PROPERTIES OF ORGANIC SEMICONDUCTORS BASED ON POLYVINYLACETATE. Grishina, A. D.; Vannikov, A. V.; Ashin, S. B.; Bakh, N. A. (Inst. of Electrochemistry, Moscow). Sov. Phys.-Solid State (Engl. Transl.), 9: 1298-1301(Dec. 1967).

Translated from Fiz. Tverd. Tela, 9: 1651-4(June 1967).

Fast-electron (6 MeV) irradiation of polyvinylacetate films, prepared by radiation-thermal modification, reduced the concentration of paramagnetic centers and increased the conductivity without a change in the activation energy. The higher the temperature of heat treatment, the stronger were these effects. Annealing of irradiated samples at temperatures exceeding 125°C resulted in a complete reestablishment of the electrical and paramagnetic properties of the original unirradiated films. An interpretation of the observed effects is given. (auth)

5444 THEORIES OF MAGNETISM IN METALS. Anderson, P. W. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 197-213 of Proceedings of the Fifth Annual Eastern Theoretical Physics Conference, Brown University, Providence, November 25–26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-661129.

Theories of magnetism in metals are considered and the progress made in the last two years is described. (W.D.M.)

5445 QUANTUM LATTICE GAS AND THE HEISENBERG–ISING ANTIFERROMAGNETIC CHAIN. Yang, C. N. (State Univ. of New York, Stony Brook). pp 215-25 of Proceedings of the Fifth Annual Eastern Theoretical Physics Conference, Brown University, Providence, November 25–26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-661129.

The Hamiltonian is given by a sum of nearest neighbor interactions, described by spin matrices at various lattice sites. The problem discussed is the physics generated by such a Hamiltonian. The ground state energy, the excitation energy, and the finite temperature behavior are considered. (W.D.M.)

5446 STABILITY OF MATTER. Dyson, F. J. (Inst. for Advanced Study, Princeton, N. J.). pp 227-39 of Proceedings of the Fifth Annual Eastern Theoretical Physics Conference, Brown University, Providence, November 25–26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-661129.

The problem considered is whether the laws of quantum mechanics are sufficient by themselves to make matter, an assemblage of positive and negative coulomb charges, stable in the sense that the forces are saturating. That is, one cannot get more energy out of a system than a certain number proportional to the number of particles. (W.D.M.)

5447 THE SKIN EFFECT. I. INTRODUCTION; THE CURRENT DISTRIBUTION FOR VARIOUS CONFIGURATIONS. Casimir, H. B. G.; Ubbink, J. (Philips Research Labs., Eindhoven, Netherlands). Philips Tech. Rev., 28: 271-83 (1967).

This first part of a series of articles on the skin effect contains a general introduction followed by a discussion of the current distribution for several configurations. The essence of the skin effect is illustrated by the case of a number of parallel wires in one plane, connected in parallel. The standard problem of the cylindrical wire is used to introduce the "classical skin depth." The problem of the current distribution in a conductor of any shape is stated in general terms. If the skin layer is thin, the problem of the distribution along the surface is reduced to a potential problem; in the case of a cylindrical wire of any cross section, the surface current distribution is the same as the charge distribution along the surface of a charged conductor of the same shape. This is applied to a flat strip. The problem becomes purely unidimensional in the case of two strips which together form a flat coil. Finally the case of a ferromagnetic sphere in a magnetic alternating field is discussed. The combination of skin effect and ferromagnetism can lead to "temperature hysteresis": The temperature of the sphere as a function of the amplitude of the field is different for increasing and decreasing amplitude. (auth)

5448 INVESTIGATIONS OF Tb^{3+}-ACTIVATED PHOSPHORS. Blasse, G.; Bril, A. Philips Res. Rep., 22: 481-504(Oct. 1967).

The fluorescence of a large number of Tb^{3+}-activated phosphors (mainly oxides, but also oxyhalides and fluorides) is reported and discussed. The dependence of the spectral-energy distribution of the emission on the surroundings is much weaker than in the case of Eu^{3+}-activated phosphors. This seems to be connected with the absence of charge-transfer absorption bands in the uv region for Tb^{3+}-activated oxides. The position of the 4f–5d absorption band is found to depend strongly on the host lattice. The factors influencing the position of this band (nephelauxetic effect, crystal-field splitting) are discussed. They can be recognized from the experimental results. Especially in the garnet structure the crystal-field splitting of the 5d level gives interesting results. Energy transfer from a certain host lattice to Tb^{3+} is in general found to be less efficient than the transfer from the same lattice to Eu^{3+}. Several possible reasons for this phenomenon are put forward. Finally it is shown that the maximum quantum efficiency in the uv region is determined by the deviation from inversion symmetry at the Tb^{3+} site and the position of the 4f–5d absorption band of the Tb^{3+} ion. The larger the deviation and the longer the wavelength of the 4f–5d band, the lower the efficiency is. (auth)

5449 GAMMA-RADIATION EFFECTS ON ELECTRO-OPTIC PROPERTIES OF SEIGNETTOELECTRICS. Ivanov, N. R.; Shuvalov, L. A. (Inst. of Crystallography, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1148-53(July 1967). (In Russian).

Electro-optic properties of Y-section triglycine sulfate crystals irradiated by ^{60}Co γ rays with 1- to 5-MR doses were studied at room temperature. The results obtained were compared with the measurements of nonirradiated specimens. Temperature dependence of the optic turn indicatrix in the range from 20 to 70°C was determined. Electro-optic hysteresis loops of specimens were investigated at room temperature and compared with the loops of dielectric hysteresis. (R.V.J.)

5450 PSEUDOPOTENTIAL COEFFICIENTS AND SPIN-ORBIT COUPLING IN METALLIC CADMIUM. Maryakhin, A. A.; Svecharev, I. V. (Physical-Technical Inst., Kharkov). Phys. Status Solidi, 23: K133-6(1967).

The experimental data for the Fermi surface allow a determination of the parameters of the effective lattice potential by fitting in an electronic computer. In the case of Cd a great number of Bragg planes and spin–orbit coupling have to be taken into account, and the order of the corresponding secular determinant proves to be high; the computing time may be shortened by the following computational scheme. The approximated values of parameters can be determined from the data of the radio-frequency size effect whose precision is improved due to recommendations of Gantmacher and Krylov (1966). The effect gives the dimensions of the Fermi surface sections along the symmetry lines where the order of the secular determinant is decreased so that the calculation of the parameters is easily done manually. These values were refined in the computer using all of the available information on Cd. Approximate values of pseudopotential coefficients and spin–orbit level splitting in K and S_1^+ are presented here, their accuracy is sufficient for most practical purposes of the experimenters. Computed parameters are: $V_{002} = -0.052$ Ry, $V_{100} = -0.006$ Ry, $V_{101} = +0.024$ Ry, $\Delta E_{K_3} = 0.014$ Ry, and $\Delta E_{S_1^+} = 0.006$ Ry in S_1^+. (TSS)

5451 EFFECT OF GAMMA AND NEUTRON IRRADIATION ON THE FERROMAGNETIC RESONANCE IN FERRITES. Lebed', B. M.; Mukha, L. Ya.; Mosel', V. I.; Ulmanis, U. A. Sov. Phys.-Solid State (Engl. Transl.), 9: 1342-5(Dec. 1967).

Translated from Fiz. Tverd. Tela, 9: 1708-12(June 1967).

The results are reported of an experimental investigation of the influence of integral gamma and neutron fluxes on the ferromagnetic relaxation in a single crystal of an yttrium iron garnet. The influence of radiation defects on the magnetic relaxation is analyzed. (auth)

5452 LUMINESCENCE OF X-RAY-IRRADIATED KCl:Cu CRYSTALS CAUSED BY SMALL DEFORMATIONS. Shmurak, S. Z.; Eliashberg, M. B. (Inst. of Solid State Physics, Chernogolovka, USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 1427-8(Dec. 1967).

Translated from Fiz. Tverd. Tela, 9: 1818-20(June 1967).

The effect of elastic deformation on luminescence of crystals was studied using KCl : Cu single crystals, irradiated with x rays at room temperature for 30 min. The irradiated crystals were placed between two dies with special provision for deformation, and subjected to uniaxial compression with a discrete series of loads. Directly after irradiating the crystals phosphorescence was observed, which formed a background for the bursts that appeared when stress was applied to the crystal. (M.H.R.)

5453 THERMAL EXPANSION OF GADOLINIUM. Finkel, V. A.; Smirnov, Yu. N.; Vorobyov, V. V. (Gorky State Univ., USSR). Phys. Status Solidi, 23: K97-8(Sept. 1, 1967). (In German).

Previous studies on the crystal structure of Gd have shown a considerable anisotropy of the thermal expansion. The temperature dependences of the angles β (the angle formed by the direction in which the linear expansion coefficient is zero and the hexagonal axis [001]) and ω (the angle between the spin and the [001] axis) have the same pattern within the measurement accuracy. This means that the crystal structure of Gd along the direction of the effective magnetic moment is stable. The maxima in the β(T) and ω(T) curves are related to the topology modification of the Fermi circuits. (J.S.R.)

5454 HANDBOOK OF X-RAYS: FOR DIFFRACTION, EMISSION, ABSORPTION, AND MICROSCOPY. Kaelble, Emmett F. (ed.). New York, McGraw-Hill Book Co., 1967. 1120p. $35.00.

Fundamentals are covered first which are common to all the areas subsequently treated. Properties, generation, detection, and measurement of x rays, geometry of crystals, design of a typical x-ray laboratory, and health and safety are discussed. Diffraction of x rays by polycrystalline and amorphous materials, determination of crystal structure, x-ray emission spectroscopy, x-ray absorption methods, and microradiography and x-ray microscopy are taken up. Among the recent advances covered are: trace analysis by x-ray spectroscopy, soft x-ray spectroscopy, electron probe microanalysis, process stream x-ray analyzers, high- and low-temperature diffraction, and characterization of polymers. (M.H.R.)

5455 MOESSBAUER EFFECT METHODOLOGY. VOLUME 3. Proceedings of the Third Symposium, New York City, January 29, 1967. Gruvermann, Irwin J. (ed.). New York, Plenum Press, 1967. 258p. (CONF-670110–(Vol.3)). DTIE.

Separate abstracts were prepared for the twelve papers of this volume. (M.H.R.)

For abstracts of individual papers see: 5456–5465, 5791, and 5875.

5456 CHEMICAL AND MAGNETIC ORDER IN ALLOY PHASES. Kimball, C. W. (Northern Illinois Univ., Dekalb). pp 3-14 of Moessbauer Effect Methodology. Vol. 3. Gruvermann, Irwin J. (ed.). New York, Plenum Press, 1967.

From 3rd Annual Moessbuaer Symposium, New York, Jan. 29, 1967. See CONF-670110–(Vol.3).

The discernment of chemical order or the simultaneous presence of several types of magnetic order by means of Mössbauer spectroscopy is discussed for both metallic solid solutions and intermediate alloy phases. The tendency for iron to preferentially occupy specific sites in intermetallic compounds is revealed by an analysis which combines line position and intensity. The existence of chemical order may also require an analysis of the shape of the absorp-

tion pattern. As typical examples, the complex magnetic order in $Pt_{3-x}Fe_{1+x}$ (near Pt_3Fe), chemical ordering in solid solutions of iron in vanadium, and preferential site occupation in compounds of the FeMn system are considered. (auth)

5457 APPLICATIONS OF ^{119m}Sn MOESSBAUER SPECTROSCOPY TO CHEMICAL PROBLEMS. Zuckerman, J. J. (Cornell Univ., Ithaca, N. Y.). pp 15-36 of Moessbauer Effect Methodology. Vol 3. Gruvermann, Irwin J. (ed.). New York, Plenum Press, 1967.

From 3rd Annual Moessbauer Symposium, New York, Jan. 29, 1967. See CONF-670110-(Vol.3).

The first observation of the Moessbauer effect in ^{119}Sn was quickly followed by the application of ^{119m}Sn Moessbauer spectroscopy to a chemical problem. There are now almost two hundred research papers and notes which comprise the literature of ^{119m}Sn Moessbauer spectroscopy. The great majority of these describe applications to chemical problems. Spectroscopic methods are inherently capable of yielding three general types of information: (1) identity of a substance, (2) composition of a physical mixture, and (3) information concerning the structure and bonding of atoms in molecules. The first of these represents an application of the generally accepted principle that "identical species behave identically," and the second operates on the premise that physical mixing does not alter chemical nature. These two are analytical uses. It is the third type of information which the chemist is most anxious to have. In most cases it is impossible to derive exact theoretical predictions concerning the change of measurable parameters from the first principles, and the practicing chemist must, therefore, rely on a large body of analogy upon which to build his hypotheses. In the case of a technique only recently introduced, it is necessary first to test a wide variety of substances in order to find the empirical correlations which relate the known chemical behavior to changes in the observable parameters. This process has already been seen to occur in infrared and nuclear magnetic resonance spectroscopy. The present state of the science of ^{119m}Sn Moessbauer spectroscopy is reviewed. (auth)

5458 METALLURGICAL USES OF THE ^{57}Fe MOESSBAUER EFFECT IN METALLIC IRON AND PLAIN CARBON STEELS. Christ, B. W.; Giles, P. M. (National Bureau of Standards, Washington, D. C.). pp 37-65 of Moessbauer Effect Methodology. Vol. 3. Gruvermann, Irwin J. (ed.). New York, Plenum Press, 1967.

From 3rd Annual Moessbauer Symposium, New York, Jan. 29, 1967. See CONF-670110-(Vol.3).

Literature describing the ^{57}Fe Mössbauer effect in metallic iron, steels, and ferrous compounds occurring in steels is reviewed and compared with new, computer-analyzed data obtained in 298°K measurements on metallic iron and carbon steels. Characteristics of Mössbauer patterns are sensitive to carbon content and thermomechanical history. Relative to standard sodium nitroprusside, the average effective magnetic field for three grades of recrystallized iron is 339 ± 2 kOe. Patterns reveal several superimposed hyperfine interactions between 0.02 and 1 wt % carbon. The most intense magnetic hyperfine pattern is attributable to iron atoms remote from interstitials. The effective magnetic field of this pattern increases with increasing C in solution, e.g., 355 ± 3 kOe at 1 wt % C. In quenched 0.3, 0.7, and 1 wt % C alloys, irregularities in peak shape arise from sets of iron atoms with various C near-neighbor configurations. A weak, resolvable magnetic hyperfine pattern exhibiting a small quadrupole effect and an effective magnetic field 20% smaller than that of the intense pattern originates at iron atoms with one carbon nearest-neighbor. Phases identifiable by their patterns include ferrite, martensite, austenite, cementite, and ϵ-carbide. Dislocations produce no appreciable effect. Application of Mössbauer spectroscopy to the study of martensite tempering and for quantitative analysis for retained austenite is discussed. (auth)

5459 APPLICATIONS OF MOESSBAUER SPECTROSCOPY TO EXPLOSIVES. Allard, Edward F. (Army Engineer Research and Development Lab., Fort Belvoir, Va.). pp 67-77 of Moessbauer Effect Methodology. Vol. 3. Gruvermann, Irwin J. (ed.). New York, Plenum Press, 1967.

From 3rd Annual Moessbauer Symposium, New York, Jan. 29, 1967. See CONF-670110-(Vol.3).

Moessbauer spectroscopy is being used to study primary and secondary explosives. The most common primary explosives, lead azide, silver azide, and mercury fulminate can be studied if they can be doped with a suitable Moessbauer isotope. Lead azide has been doped with iron, but the exact nature of the doping is not known yet. Preliminary experiments show that ferrous and ferric picrate powders display quadrupole splitting. Exact calculations of the EFG cannot be determined until the structures of the iron picrates are known. Moessbauer spectroscopy is being used to study thin films of explosives; if successful, this technique would be a major contribution to explosives research. (auth)

5460 PHILOSOPHY OF RESEARCH: NEW PROJECTS IN MOESSBAUER SPECTROSCOPY OF SYSTEMS WITH WEAK MAGNETIC INTERACTIONS. Mulay, L. N. (Pennsylvania State Univ., University Park). pp 79-102 of Moessbauer Effect Methodology. Vol. 3. Gruvermann, Irwin J. (ed.). New York, Plenum Press, 1967.

From 3rd Annual Moessbauer Symposium, New York, Jan. 29, 1967. See CONF-670110-(Vol.3).

Some basic philosophies of the author concerning "research" versus "investigation" are dealt with and a need for developing Moessbauer spectroscopy as a "problem-oriented" research tool is discussed. A brief survey of dia-, para-, and anti-ferromagnetism is presented and specific research problems to which Moessbauer spectroscopy can be (or has been) applied are discussed. These include coordination and organometallic compounds. (auth)

5461 SUPERPARAMAGNETISM AND MOESSBAUER SPECTROSCOPY: A REVIEW AND NEW RESULTS ON IRON DISPERSION. Collins, D. W.; Dehn, J. T.; Mulay, L. N. (Pennsylvania State Univ., University Park). pp 103-22 of Moessbauer Effect Methodology. Vol. 3. Gruvermann, Irwin J. (ed.). New York, Plenum Press, 1967.

From 3rd Annual Moessbauer Symposium, New York, Jan. 29, 1967. See CONF-670110-(Vol.3).

Super or collective paramagnetism and the possible applications of Moessbauer spectroscopy to collectively paramagnetic systems such as oxides, catalysts with metal dispersions on the surface of diamagnetic supports, and dispersions within a silicate matrix are dealt with. The last-named area represents a superparamagnetic system, developed and studied in our laboratory. Papers dealing with the Moessbauer spectra of superparamagnetic systems are reviewed and the possibilities of relations between the relative line intensities of quadrupole-split Moessbauer spectra and the cluster sizes of superparamagnetic systems are considered. (auth)

5462 ELECTRIC FIELD GRADIENT TENSOR. Collins, R. L.; Travis, J. C. (Univ. of Texas, Austin). pp 123-61 of Moessbauer Effect Methodology. Vol. 3. Gruvermann, Irwin J. (ed.). New York, Plenum Press, 1967.

From 3rd Annual Moessbauer Symposium, New York, Jan. 29, 1967. See CONF-670110-(Vol.3).

The quadruple splitting of ^{57}Fe Moessbauer spectra has not been generally useful for structure and bonding studies, although many useful applications have been made of isomer shift. This is so for good reason—the quadrupole splitting is a function of the two independent parameters of the electric field gradient (EFG) tensor. Alone, it determines neither parameter. Several methods exist for the determination of these parameters, and most generally applicable one is due to Ruby and Flinn. A large magnetic field, typically produced by a superconducting magnet, splits the remaining degeneracies and gives characteristic distortions to the initially quadrupole-split lines. J. R. Gabriel's theoretical program for this effect, modified slightly, has been run on a fast digital computer for a number of fields, splittings, line widths, and parameters of the EFG tensor. Local vibrational anisotropy is explicitly omitted in this treatment. The results are generally useful in guiding the interpretation of magnetically split spectra. Applications are discussed. The method appears to possess general utility and should enlarge considerably the contribution of Moessbauer spectroscopy to studies of structure and bonding. These results are applicable to ^{119}Sn compounds as well. (auth)

5463 THE APPLICATION OF ON-LINE COMPUTER TECHNIQUES TO MOESSBAUER SPECTROSCOPY. Goodman, R. H. (Dept. of Energy, Mines, and Resources, Ottawa). pp 163-76 of Moessbauer Effect Methodology. Vol. 3. Gruvermann, Irwin J. (ed.). New York, Plenum Press, 1967.

From 3rd Annual Moessbauer Symposium, New York, Jan. 29, 1967. See CONF-670110-(Vol.3).

The use of multi-channel pulse-height analysis equipment for obtaining Moessbauer spectra is a well established technique. The transducer is operated in a constant-acceleration mode and the total spectrum is scanned at a rate of a few cycles per second. The use of a small on-line computer for obtaining Moessbauer spectra is discussed. The techniques are in some ways similar to those employed for multichannel analyzers, but the on-line computer offers increased flexibility. The on-line computer system has been developed over a period of two years in our laboratory, and various techniques for interfacing the Moessbauer spectrometer and computer have been tried. The relative advantages of each technique are discussed, and a system which runs three Moessbauer spectrometers, time-sharing the same computer, is described. The problems in interfacing a specific computer are

presented, the Digital Equipment PDP8, but the techniques may be applied to computers of other manufacturers. Details of the interface for the PDP8 are given. This equipment has been used to study Moessbauer spectra of the iron–copper–sulfur system using ^{57}Fe. Some of these spectra are presented and an outline of a possible interpretation is given. (auth)

5464 THE MOESSBAUER EFFECT IN ^{133}Cs. Perlow, G. J. (Argonne National Lab., Ill.). pp 191-201 of Moessbauer Effect Methodology. Vol. 3. Gruvermann, Irwin J. (ed.). New York, Plenum Press, 1967.

From 3rd Annual Moessbauer Symposium, New York, Jan. 29, 1967. See CONF-670110–(Vol.3).

The recoilless nuclear gamma-ray resonance of the 81-keV transition in ^{133}Cs has been observed and a number of experiments have been done and reported to date by the author and his collaborators. The following subjects are discussed here: (1) properties of the transition; (2) appearance of the pulse-height spectrum; (3) preparation and properties of the sources; (4) apparatus used in the measurements; and (5) a summary of experiments to date. Under item (5) the following are briefly discussed: (a) the healing of the Auger cascades following electron-capture decay in ^{133}Ba, (b) the value of f_s in a barium–aluminum alloy source; (c) the isomer shifts in a variety of substances; (d) the value of f_s and θ_m for cesium metal; (e) the search for a spin-density-wave state in cesium metal; and (f) the Debye–Waller factor for the cesium halides. (auth)

5465 PRESENT STATUS OF EXPERIMENTS WITH ^{121}Sb. Ruby, S. L. (Argonne National Lab., Ill.). pp 203-15 of Moessbauer Effect Methodology. Vol. 3. Gruvermann, Irwin J. (ed.). New York, Plenum Press, 1967.

From 3rd Annual Moessbauer Symposium, New York, Jan. 29, 1967. See CONF-670110–(Vol.3).

During the past year, a variety of materials containing antimony have been studied. Experimental methods are described, along with information on various methods of source preparation. Results are presented on the previously unknown excited-state quadrupole and magnetic moments. An interpretation of the isomer shifts is given which places great emphasis on pairs of materials for which their tin and antimony atoms are thought to be isoelectronic. Hartree–Fock computations are described that enable a first estimate for the change in nuclear radius: $\delta r/r = (-8.1 \pm 3.0)\ 10^{-4}$. (auth)

Theoretical Physics

Refer also to abstracts 5615 and 5872.

5466 (BARC–292) FIELD THEORY TECHNIQUE AS APPLIED TO ELECTRONS IN EXTERNAL FIELD. Khubchandani, P. G.; Manohar, C. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 58p. Dep.

The problem of external fields in a many-particle system is treated by field theory techniques, neglecting the interaction between the particles. The technique is applied specifically to fermions, especially electrons, and its advantages are shown by examples like the summation of diagrams, derivation of linked cluster expansion, etc. The study starts with the Hamiltonian in terms of the wave field operators and then proceeds as in field theory to annihilation and creation operators, treating the many-body system as though it is a highly excited field. Screening of impurities is treated at the end after the inclusion of electron–electron interactions. (M.H.R.)

5467 (JINR–P9-3542) MAGNITNOE POLE RAVNOMERNO NAMAGNICHENNYKH OB'EMOV TSILINDRICHESKOI KONFIGURATSII. (Magnetic Field of Uniformly Magnetized Cylindrical Configurations). Danilov, V. I.; Ianovich, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 34p. (In Russian). Dep.

A general method for calculating the expressions for the magnetic field components of magnetized annular cylindrical sectors, regarded as the general case of cylindrical configurations of constant height, is described. The theory is based on the assumption that the volume of the cylindrical configuration is uniformly magnetized. It is also shown that the expressions obtained for such uniformly magnetized bodies can be used for the determination of the field outside and inside a single-layer fine-wire annular sectorial solenoid. (auth)

5468 (NP–17121) NONRELATIVISTIC APPROXIMATIONS OF THE DIRAC HAMILTONIAN. de Vries, E. (Groningen Rijksuniversiteit (Netherlands). Instituut voor Theoretische Fysica). Aug. 1966. 30p. (IR–69). Dep.

Methods for obtaining approximate expressions for the Dirac Hamiltonian for the case $v/c \ll 1$ are compared. Difficulties encountered in these methods are discussed. The Hamiltonian to order $(v/c)^6$ was calculated with one of these methods. (M.O.W.)

5469 SYNCHROTRON RADIATION FROM ELECTRONS IN HELICAL ORBITS. Epstein, Richard I.; Feldman, P. A. (Stanford Univ., Calif.). Astrophys. J., 150: L109-10(Nov. 1967).

This letter constitutes a correction of some of the commonly used results of synchrotron radiation theory. The relevance of these revisions to the interpretation of astronomical observations is also discussed. (auth)

5470 A PROPOSED TEST OF BLACKETT'S HYPOTHESIS USING SUPERCONDUCTORS. Cranna, K. G.; Papini, G. (Univ. of Saskatchewan, Regina). Nuovo Cim. (10), 52B: 241-3(Nov. 11, 1967).

Blackett proposed in 1947 a series of experiments to test the hypothesis that any rotating mass generates a magnetic field. It is proposed here to test Blackett's hypothesis using superconductors. (W.D.M.)

5471 EFFICIENCY OF THE METHOD OF MATHEMATICAL EXPECTATION FOR PROBLEMS OF THE SAME CLASS. Khisamutdinov, A. I. Zh. Vychisl. Mat. Mat. Fiz., 7: 946-53 (July-Aug. 1967). (In Russian).

The problem of estimating the value of the functional $I = (F,\phi)$ from the density of gamma quanta collisions F by the method of Monte Carlo is considered. The interaction of gamma quanta with the medium is limited to Compton scattering and the photoelectric effect. The collision density F also satisfies the integral equation $F = KF + F_1$, where F_1 is the density of primary collisions. The method of mathematical expectation is used to estimate the functional and the dispersion. In gamma–gamma borehole exploration the scattered gamma quanta reach a very small gamma detector through a collimated slit in a lead shield. The probability of a gamma quantum entering the detector is estimated and compared with the experimental dispersion. The experimental results are in good agreement with the theoretical values. (TTT)

5472 ON THE MICROSCOPIC THEORY OF CHERENKOV RADIATION. Pratap, R. (Univ. Libre, Brussels). Nuovo Cim. (10), 52B: 63-97(Nov. 11, 1967).

The energy loss suffered by a relativistic charged particle passing through a medium consisting of classical charged oscillators was investigated. The whole treatment is in the Lorentz gauge. Starting from the formal solution of the Liouville equation, the one-particle distribution function was obtained. This function was used to calculate the Cherenkov loss. The Cherenkov threshold condition was obtained. The formulation used here is essentially the one proposed by Prigogine and developed by him and co-workers. (auth)

5473 APPLICATION OF A HIGHER-ORDER WKB APPROXIMATION TO RADIAL PROBLEMS. Krieger, J. B.; Rosenzweig, C. (Polytechnic Inst. of Brooklyn). Phys. Rev., 164: 171-3(Dec. 5, 1967).

The radial generalization of Dunham's one-dimensional WKB quantization condition, including second- and third-order corrections is derived using the Langer transformation. It is found that, although the first-order integral can be obtained from Dunham's results by substituting $(l + \frac{1}{2})^2$ for $l(l + 1)$ in the effective potential, there is no choice of effective potential that leads to the correct second- and third-order integrals. It is suggested that all previous eigenvalue calculations using higher-order WKB approximations for the radial case should be reinvestigated. It is shown that the second- and third-order integrals identically vanish for the hydrogen atom and the three-dimensional harmonic oscillator, as expected. (auth)

5474 RENORMALIZATION OF THE MOMENT OF INERTIA FOR THE CLASSICAL ELECTROMAGNETIC ONE-BODY PROBLEM. Madore, J. (Laboratoire de Physique Theorique, Paris). Z. Naturforsch., 22a: 1477-82(Oct. 1967).

A general process of renormalization of the energy–momentum vector and the angular-momentum tensor is given. It is shown that in the simple limiting case of a charged line segment rotating about a fixed point of symmetry, this process reduces to a renormalization of the moment of inertia analogous to the mass renormalization given by Dirac for the limiting case of a point particle. (auth)

5475 LOWER BOUNDS TO THE MANY-BODY PROBLEM USING DENSITY MATRICES. Kijewski, L. J.; Percus, J. K. (New York Univ., N. Y.). Contracts AT(30-1)-1480; AF-AFOSR-945-65. Phys. Rev., 164: 228-34(Dec. 5, 1967).

Variation principles for obtaining lower bounds by means of density matrices are applied to a number of many-body problems

This is done by means of restrictions derived from the study of exactly solvable models. Two classes of problems are considered: (a) obtaining a lower bound to the ground-state energy of a system of particles, and (b) obtaining a lower bound to the Helmholtz free energy. For the first case an exact lower bound is obtained for the ground-state energy of the particle-conserving Bogolyubov Hamiltonian. Of particular significance in the nonzero temperature case is a rigorous lower bound to the free energy of the Ising model with small external field at low temperatures. (auth)

5476 MAXIMUM POLARIZATION OF SYNCHROTRON RADIATION. Bagrov, V. G. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 8, 135-7(1967). (In Russian).

The change in the degree of linear polarization of synchrotron radiation was examined as a function of the orientation of the polarization plane. (tr-auth)

5477 EFFECT OF A CONSTANT UNIFORM MAGNETIC FIELD ON THE SCATTERING OF ELECTROMAGNETIC WAVES BY FREE ELECTRON. Dutt, Jayanti (Lucknow Univ., India); Bali, L. M.; Vachaspati. Indian J. Pure Appl. Phys., 5: 267-71 (July 1967).

The equation of motion of an electron in the presence of an external electromagnetic field and a constant uniform magnetic field is solved using a perturbation method. It is shown that the scattered field consists of waves of fundamental frequency, the gyration frequency, their harmonics, and their sun and difference frequencies. The effect of the applied magnetic field on the intensities of the scattered waves of fundamental frequency and its second harmonic is discussed. It is shown that the first and second harmonic cross sections become comparable when the incident frequency is equal to or half the gyration frequency of the electron. Variation of these cross sections with the direction of the applied magnetic field is also discussed. (auth)

5478 DISPLACEMENT AND COLLECTIVE VARIABLES METHOD OF QUANTUM STATISTICS. Yukhnovskii, I. R. (Lvov State Univ.). Ukr. Fiz. Zh., 12: 1677-94(Oct. 1967). (In Russian).

The basis of the displacement and collective variables method is presented for the Slater operator $\exp - \beta H$. An initial formula of the method is obtained: $\exp - \beta(H_0 + V) = Se^{U(\rho)}J(\rho r)\exp - \beta H_0 T \exp.\ (V_\rho + V_{itra} + D)\ (d\rho)$, in which ρ_k – collective variables, $J(\rho r)$ – the function of transition to the collective variables – ΘV_ρ is equal to the potential of interaction between the collective variables and individual degrees of freedom, and $-\Theta V_{itra}$ is equal to the potential of screened two-particle interaction among packets. The values of a screening radius and a packet are obtained. $U_{(\rho)}$ is the displacement function, presented by a series according to the powers ρ_k. It is shown that at high temperature $\exp U_{(\rho)}$ gives the main contribution. The quantum correction values are presented. In the domain of the absolute zero the Slaiter operator can have the expression $\exp - \beta H_0 T \exp V_{itra}$. The first diagram is calculated and investigated and the diagrams of higher orders are shown to coincide. Besides, the expansion according integral powers r_s is shown to be unfinished and can satisfy only very small r_s. (auth)

5479 SYMMETRIZATION POSTULATE OF QUANTUM MECHANICS. Flicker, Michael; Leff, Harvey S. (Case Western Reserve Univ., Cleveland). Phys. Rev., 163: 1353-7(Nov. 25, 1967).

On the basis of reasonable physical assumptions, it is proved that for systems of identical spinless particles, the permissible nonrelativistic Schrödinger wave functions are either all symmetric or all antisymmetric. The proof is a generalization of that given by Girardeau. Although connectivity properties of the configuration space play an important role in the proof, it is not true, as was previously believed, that a connected space is always necessary. In particular, for one-dimensional systems, connectivity of the configuration space is not necessary for the proof to hold. (auth)

5480 NEW FORMULATION OF TIME-DEPENDENT PERTURBATION THEORY. Chung, Kwong T. (State Univ. College, Fredonia, N. Y.). Phys. Rev., 163: 1343-7(Nov. 25, 1967).

The previous time-dependent variation-perturbation theory, which is derived from the conventional time-dependent perturbation equations, contains two inconvenient features. When the perturbation becomes static, the wave function so obtained does not satisfy the time-dependent Schrödinger equation, and the perturbation equations cannot be reduced to the ordinary time-independent perturbation equations. To remove these difficulties, a perturbed time-dependent phase factor is introduced in deriving a new set of perturbation equations. The variation-perturbation functionals are then constructed as in the previous theory; the perturbed wave functions are solved by minimizing these functionals. The same method is also applied to many-electron systems, using the coupled and uncoupled Hartree-Fock scheme. (auth)

5481 CLASSICAL STATISTICS AS A LIMITING CASE OF QUANTUM STATISTICS. Kundt, Wolfgang (Univ., Hamburg). Z. Naturforsch., 22a: 1333-6(Sept. 1967).

The scope of validity of the quantum mechanical correspondence principle is discussed: for what classes of Hamilton functions does canonical quantization give rise to a quantum theory whose equilibrium predictions tend towards the classical ones in the limit of large energies? As the rule for canonical quantization the Weyl–Wigner map (of real phase space functions onto selfadjoint Hilbert space operators), which appears to be the simplest that guarantees commutability of quantization with continuous coordinate change in position space, is adopted. Counter examples show that there is no general validity of a correspondence principle. On the other hand, such a principle is known to hold for all physically reasonable cases. (auth)

5482 PHOTON PROPAGATION IN EXTERNAL FIELDS. Baier, R.; Breitenlohner, P. (Univ., Graz). Acta Phys. Austr., 25: 212-23(1967).

Starting from generalized Dyson equations the transverse components of the polarization tensor are calculated for a special photon momentum and magnetic field. Based on covariance arguments the polarization tensor is generalized for arbitrary photon momenta and homogeneous and constant fields. The covariant polarization tensor can be shown to depend on four invariant functions for which numerical values are listed. (auth)

5483 SOME APPLICATIONS OF INFORMATION THEORY IN QUANTUM MECHANICS. Majernik, Vladimir (Inst. of Physics, Bratislava). Acta Phys. Austr., 25: 243-59(1967).

It can be expected that there is a relation between the value of information gained about a physical state of a certain physical system and the value of energy or some other physical quantity which is necessary for it. The article presents: (1) the compatibility of the application of some information–theoretical quantities in physics; (2) determination of the general relation between quantities characterizing the quantum-mechanical system and some information–theoretical quantities; and (3) application of these results in some particular quantum-mechanical systems. Some considerations in the framework of cosmology follow from these results. (W.D.M.)

5484 ΔF, Δn, AND $\Delta\mu$ CORRECTIONS IN THE METHOD OF ASYMPTOTIC EXPANSIONS IN A MODIFIED FORMULATION OF THE PROBLEM OF A NON-IDEAL BOSE–EINSTEIN SYSTEM. Tolmachev, V. V. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 175: 1036-8(Aug. 11, 1967). (In Russian).

Previously the author developed a method for developing asymptotic expansion according to the small interactions in the problem of nonideal Bose–Einstein system of many particles. The method is based on the problem of asymptotic resolution of certain system of nonlinear integral equations for A(p), B(p), and E(p). An attempt is made of finding some corrections for the results obtained by means of the above equations. (R.V.J.)

5485 ENERGY-MOMENT METHODS IN QUANTUM MECHANICS. Delos, J. B.; Blinder, S. M. (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 47: 2784-92(Oct. 15, 1967).

Three quantum-mechanical computational techniques based on energy moments, $\mu_k = \int dq \psi^*(q)\hat{\mathcal{H}}^k\psi(q)$, and semimoments, $\nu_k(q') = [\hat{\mathcal{H}}^k\psi(q)]_{q=q'}$, are formulated. The μ method, which employs the μ_k, is connected to the method of moments in probability theory, to the variational method, and to eigenvalue spectroscopy. The ν and λ methods, which employ semimoments, are related to local energy methods using one and several configuration points, respectively. An Nth-order calculation, requiring 2N moments or semimoments, yields N approximate eigenvalues and eigenfunctions. In accordance with a conjectured convergence criterion, exact eigenstates are approached in the limit $N \to \infty$. From quantities obtained in a moment's calculation, a lower bound on the ground-state eigenvalue can also be determined using a refinement of Weinstein's criterion. A computational method for generating moments and semimoments is given and the μ method is applied to the linear harmonic oscillator. (auth)

5486 THEORY OF ENERGY TRANSFERS AND CONVERSIONS. Grabiel, Federico. New York, John Wiley and Sons, Inc., 1967. 226p. $10.95.

A unified theory of energy transfers and conversions that includes thermodynamics as a special case is presented. New extensive parameters in physics and physical chemistry are uncovered, the relations between those quantities and their corresponding intensive parameters are included. Processes in which systems pass from positive to negative values of some intensive parameter are studied, as well as the inverse processes. Dynamic processes are handled throughout and phenomena at extreme values of the intensive parameters are studied. (M.H.R.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 4600 and 5517.

5487 (COO-818-103) HIGH-ENERGY MACHINE PHYSICS. Technical Report, October 1, 1966–September 30, 1967. Reines, F.; Jenkins, T. L. (Case-Western Reserve Univ., Cleveland, Ohio). June 1967. Contract AT(11-1)-818. 6p. Dep. CFSTI.

Current high-energy physics research at Case Institute of Technology is very briefly discussed. Included topics are D_2O solar neutrino experiment and baryon stability experiment, double beta decay apparatus, high-energy physics at accelerators, and the flying spot scanner. (W.H.K.)

Electromagnetic

Refer also to abstract 5500.

5488 STUDY OF ELECTRON PAIRS IN PHOTOGRAPHIC EMULSIONS. Kamal, A. A.; Padmavathi, S. V. (Osmania Univ., Hyderabad, India). Indian J. Pure Appl. Phys., 5: 194-6 (June 1967).

From an analysis of 178 electron pairs produced in photographic emulsions, exposed to a 17-GeV/C π^- beam, the distributions of the parameters involving pair energy, opening angle and partition energy were obtained and a good agreement is found with Olsen's theory. The opening angle method for the energy determination of γ-rays was re-examined in the presence of multiple Coulomb scattering and its scope discussed. Finally the energy distribution in pairs was compared with theory. (auth)

5489 TRACKS IN MICA CAUSED BY ELECTRON SHOWERS. Russell, F. M. (Rutherford High Energy Lab., Chilton, Eng.). Nature (London), 216: 907-9(Dec. 2, 1967).

A search was made for evidence of electron showers in muscovite mica which showed tracks of muons. Definite evidence for the occurrence of these showers was found, and is summarized in this communication. (UK)

5490 PRODUCTION OF THE N*(1238) NUCLEON ISOBAR BY PHOTONS OF ENERGY UP TO 6 GeV. (Brown Univ., Providence, R. I.). Phys. Rev., 163: 1510-22(Nov. 25, 1967).

The reaction $\gamma + p \rightarrow N^*(1238) + \pi^-$ was studied in a hydrogen bubble chamber exposed to a 4.8- to 6.0-BeV bremsstrahlung beam. This channel dominates the two-pion photoproduction reaction below the 1.05-BeV ρ^0-meson threshold, and at higher energies accounts for a significant part of the $p\pi^+\pi^-$ events after subtraction of the $p\rho^0$ channel. Total and differential cross sections, and N*(1238)-decay angular correlations are presented over the energy range 0.5 to 1.8 BeV. These data are analyzed using a resonance model in which the reaction proceeds through the photoexcitation of the higher nucleon isobars—N**(1420), N**(1512), N**(1688), and possibly N**(1924). The only free parameters are the resonance strengths, which are fixed by a best fit to the total-cross-section curve. These same strengths account for the N*(1238) production angular distribution, but there remain some discrepancies between the predicted and observed N*-decay angular correlations in the lowest-energy regions covered by our fit. Thus, although the total cross sections and production angular distributions require an appreciable contribution from N**(1420) excitation, the decay angular correlations tend to minimize the contributions of this resonance. However, satisfactory agreement with all the data may be obtained with a downward shift of the N**(1512) ($J = \frac{3}{2}^-$) resonance mass by ~50 MeV. Comparison is also made between our data and the one-pion-exchange model with final-state interaction. Unless this model is drastically modified (as for example in the calculations of Stichel and Scholz), agreement with the observations is poor. (auth)

5491 MEASUREMENT OF THE PION FORM FACTOR. Akerlof, C. W.; Ash, W. W.; Berkelman, K.; Lichtenstein, C. A.; Ramanauskas, A.; Siemann, R. H. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 163: 1482-97(Nov. 25, 1967).

Cross sections for the electroproduction reaction $e + p \rightarrow e + n + \pi^+$ were measured at invariant momentum transfers $k^2 = -1$, -3, -6 F^{-2}. The circulating beam of the Cornell 2-GeV electron synchrotron struck a liquid-hydrogen target mounted in the synchrotron vacuum chamber in a field-free section between ring magnets. Pions produced along the momentum-transfer direction were counted in coincidence with inelastically scattered electrons. Both were momentum analyzed by quadrupole magnets and detected in scintillation counters and (for the electrons) a shower Cherenkov counter. The effective mass of the final pion-nucleon system was varied from 1175 to 1300 MeV. The relative contribution of transverse and longitudinal photon exchange was varied by changing the electron scattering angle. Electroproduction yields were normalized to elastic cross sections measured with the same electron spectrometer at the same incident energy. The eight measured cross sections were compared with recent dispersion calculations. The agreement is very sensitive to the value chosen for the pion charge form factor, the only free parameter in the theory. Taking into account both experimental errors (typically 10% in the cross sections) and estimates of the reliability of the theory (also around 10%) based on comparison with other experiments, the following results were obtained: $F_\pi(-1F^{-2}) = 0.79^{+0.16}_{-0.18}$, $F_\pi(-3F^{-2}) = 0.82 \pm 0.06$, and $F_\pi(-6F^{-2}) = 0.57^{+0.08}_{-0.09}$. Within the errors, the pion and proton charge form factors are identical. The pion form factor is also reasonably consistent with the ρ-exchange model: $F_\pi = (1 - k^2/m^2)^{-1}$ with $m = 600 \pm 80$ MeV. The root-mean-square charge radius of the pion is $r_\pi = (\sqrt{6})/m = 0.80 \pm 0.10$ F. (auth)

5492 PION-MASS MEASUREMENT BY CRYSTAL DIFFRACTION OF MESONIC X RAYS. Shafer, Robert E. (Univ. of California, Berkeley). Phys. Rev., 163: 1451-61(Nov. 25, 1967). (UCRL-16638).

The energies of the 4f-rd atomic transitions in pionic calcium and titanium were measured with a bent-crystal spectrometer, and were found to be 72.352 ± 0.009 and 87.651 ± 0.009 keV, respectively. The relation of these transition energies to the mass of the negatively charged pion is calculated. Comparison of the measurement with the calculation yields $M_\pi c^2 = 139.577 \pm 0.013$ MeV as a new estimate of the charged-pion mass. Conservation of energy and momentum in the $\pi \rightarrow \mu + \nu$ decay process is examined, and an upper limit of 2.1 MeV (68% confidence level) is assigned to the mass of the muon neutrino. The π^- mass measurement reported here is compared with an earlier measurement of the π^+ mass as a test of CPT invariance. It is found that $M_\pi^+/M_\pi^- = 1.0002 \pm 0.0004$. (auth)

5493 EXPERIMENTAL STUDY OF THE DECAY MODES OF THE η MESON. Buniatov, S. (CERN, Geneva); Zavattini, E.; Deinet, W.; Mueller, H.; Schmitt, D.; Staudenmaier, H. Phys. Lett., 25B: 560-5(Nov. 13, 1967).

The neutral decays of the η are studied by detecting the resulting γ's in iron-plate spark-chambers; η's are selected by a neutron missing-mass spectrometer in the reaction $\pi^- + p \rightarrow n + X$. The results are $\pi^0\gamma\gamma < 12\%$ (19% confidence) and $2\gamma = (59.0 \pm 3.3)\%$, $3\pi^0 = (41.0 \pm 3.3)\%$ assuming $\pi^0\gamma\gamma = 0$. (auth)

5494 SEARCH FOR THE DECAY MODE $\eta^0 \rightarrow \pi^0\gamma\gamma$. Jacquet, F. (Ecole Polytechnique, Paris); Nguyen-Khac, U.; Baglin, C.; Bezaguet, A.; Degrange, B.; Kurz, R. J.; Musset, P.; Haatuft, A.; Halsteinslid, A.; Olsen, J. M. Phys. Lett., 25B: 574-6(Nov. 13, 1967).

A study of 4γ events was made in the production reaction $\pi^+p \rightarrow \pi^+p + 4\gamma$ using a hydrogen target inside a heavy liquid bubble chamber. The analysis shows no evidence for the decay mode $\eta^0 \rightarrow \pi^0\gamma\gamma$. With 99% of confidence, $(\eta^0 \rightarrow \pi^0\gamma\gamma)/(\eta^0 \rightarrow \text{all modes}) < 0.12$. (auth)

5495 VIRTUAL COMPTON SCATTERING AT HIGH ENERGIES. Asbury, J. G. (Deutsches Elektronen-Synchrotron, Hamburg); Becker, U.; Bertram, W. K.; Joos, P.; Rohde, M.; Smith, A. J. S.; Jordan, C. L.; Ting, S. C. C. Phys. Lett., 25B: 565-9(Nov. 13, 1967).

Measurements were made of the large-angle asymmetrical electron-positron pair yields of the reaction $\gamma + C \rightarrow C + e^+ + e^-$ and $\gamma + Pb \rightarrow Pb + e^+ + e^-$ as a means of determining the phase and magnitude of virtual Compton scattering amplitude at high energies (4 to 6 GeV) on complex nuclei. The first reaction was studied at an invariant pair mass $m = m_\rho$, the mass of ρ^0; the second reaction over a mass interval $300 \leq m \leq 550$ MeV. (auth)

Weak

Refer also to abstracts 4473, 5024, 5172, and 5635.

5496 (UCRL-17887) SEARCH FOR THE DIRECT DECAY $K^+ \rightarrow \pi^+ + \gamma + \gamma$. Chen, M.; Cutts, D.; Kijewski, P.; Stiening, R.; Wiegand, C.; Deutsch, M. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 25, 1967. Contract W-7405-eng-48. 13p. Dep. CFSTI.

As a part of the spark chamber study of K^+ decays at rest data

were searched for examples of the direct decay $K^+ \rightarrow \pi^+ + \gamma + \gamma$. No events were found. Candidates were recognized by the relation of the conversion points of two gamma rays to the momentum of a charged particle. The charged particle was assumed to be a pion. Its momentum was determined from its range in an aluminum plate spark chamber. The apparatus was sensitive to pions having a kinetic energy between 60 and 90 MeV. The gamma rays were detected by a lead plate spark chamber. If the hypothetical direct decay process $K^+ \rightarrow \pi^+ + \gamma + \gamma$ is assumed to be distributed according to a phase space model, one can set an upper limit for the branching ratio of the K^+ into this channel of 1.1×10^{-4}. Following the suggestion of Fujii, the result was interpreted as a limit on the off-the-mass shell variation of the $K^+ \rightarrow \pi^+ + \pi^0$ amplitude. If this amplitude is assumed to be of the form $M(q^2) = M(m_{\pi^0}^2)[1 - \xi\,(q^2 - m_{\pi^+}^2/m_{\pi^0}^2)]$ the result requires that $|\xi| < 30$. In this expression q is the invariant mass of the two gamma rays. The results are incompatible with the suggestion of Lapidus that the $K^+ \rightarrow \pi^+ + \gamma + \gamma$ mode may be related to the $\eta \rightarrow \pi^0 + \gamma + \gamma$ mode through a σ meson intermediate state model. The rate of $K^+ \rightarrow \pi^+ + \gamma + \gamma$ predicted by Lapidus is more than an order of magnitude greater than that obtained from the upper limit of the branching ratio. It is noted however that this conclusion depends on the reported value of the branching ratio of $\eta \rightarrow \pi^0 + \gamma + \gamma$ decay. (auth)

5497 K^+ RARE DECAY MODES. Bisi, V.; Cester, R.; Chiesa, A. Marzari; Vigone, M. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Phys. Lett., 25B: 572-3(Nov. 13, 1967).

The rate of $K^+ \rightarrow \pi^+ + \pi^- + \mu^+ + \nu$ decay mode has been determined in deuterium bubble chamber. Limits for the rates of the modes $K^+ \rightarrow \mu^+ + \mu^- + \pi^+$ and $K^+ \rightarrow e^+ + e^- + \pi^+$ are also given. (auth)

Strong (Baryon-Induced)

5498 (BNL-11890) PROTON-NUCLEI REACTIONS AT 1-GeV INCIDENT ENERGY. Friedes, J. L. (Brookhaven National Lab., Upton, N. Y.). Oct. 30, 1967. 28p. (CONF-671040-2). Dep. CFSTI.

From Meeting of the Division of Nuclear Physics, Madison, Wis.

The relation between nuclear structure studies from high-energy electron scattering experiments with data from 1-GeV proton-nuclei elastic scattering is investigated by proton scattering from helium-4, oxygen-16, and carbon-12 at 1 GeV. The resulting behavior of the cross sections is shown. It is found that results from the Glauber theory are encouraging. (J.F.P.)

5499 (INP-567/PL/PH) SCATTERING OF VERY HIGH ENERGY PARTICLES FROM NUCLEI AND NUCLEON-NUCLEON CORRELATIONS. Czyz, W. (Institute of Nuclear Research, Krakow (Poland)). 1967. 27p. Dep.

An attempt to understand the recent experiments of high energy electron and nucleon scattering from nuclei is presented. (auth)

5500 MASS AND BINDING ENERGY OF HEAVY SHORT-RANGE HYPERFRAGMENTS. Deka, G. C. (Cotton Coll., Gauhati, India); Goswami, T. D. Indian J. Pure Appl. Phys., 5: 191-3(June 1967).

The masses of the short-range hyperfragments (HF) were determined from an analysis of the parent stars produced in nuclear emulsion stacks exposed to a 3.5 GeV/C negative pion beam and a 20 GeV/C proton beam. The mass value was found to lie between 40 and 80 proton mass (m) and about 35 percent of the samples studied have light HFs of mass $\lesssim$40 m. The limiting value of B_Λ, the Λ^0-hyperon binding energy was estimated from a study of the total visible energy release in the nonmesonic decays of heavy HFs. A fair agreement between the value of B_Λ computed and those reported in literature was observed. The possible sources of error in B_Λ determination are also discussed. (auth)

5501 POLARIZED PROTON TARGETS AND LOW-ENERGY NUCLEON-NUCLEON EXPERIMENTS. Lehar, F.; Winternitz, P. (Joint Inst. for Nuclear Research, Dubna, USSR). Fortschr. Phys., 15: 495-536(1967).

The possible use of a polarized proton target in the investigation of low-energy nucleon-nucleon interactions is reviewed. The reconstruction of the scattering matrix and verification of P-, T-, and isotropic invariances are briefly discussed. Possible sources and detectors of polarized particles are considered. The problems of phase-shift analysis and nucleon-nucleon potentials are treated. Tables of experimental values are given for the polarization of nucleons scattered on nucleons. Experimental quantities determined from the phase-shift analysis are given in graphs for the energies 14.5 and 23.1 MeV. (auth)

5502 EXPERIMENTAL RESULTS ON THE ($K\bar{K}$) AND ($K\bar{p}$) SYSTEMS AS OBSERVED IN THE ANNIHILATIONS $\bar{p}p \rightarrow K\bar{K}\pi$ AT REST. Conforto, B. (CERN, Geneva); Marcehal, B.; Montanet, L.; (and others). Nucl. Phys., B3: 469-503(1967).

In the course of an extensive study of $\bar{p}p$ annihilations at rest involving $K\bar{K}$ pairs in the final state. 2000 events $\bar{p}p \rightarrow K_1^0 K^\pm \pi^\mp$ and 364 events $\bar{p}p \rightarrow K_1^0 K_1^0 \pi^0$ were analyzed. This analysis shows that the $K^*(891)$ is strongly produced. In addition, a $K\bar{K}$ $J^P = 2^+$ resonance at 1280 MeV and a significant enhancement in the $K\bar{K}$ system at threshold, in I = 1 are observed. Also S-wave ($K\pi$) amplitudes are needed to reproduce the distribution of events on the Dalitz plot. (auth)

5503 NUCLEON-NUCLEON POLARIZATION BETWEEN 300 AND 700 MeV. Cheng, David (Univ. of California, Berkeley); MacDonald, Burns; Helland, Jerome A.; Ogden, Philip M. Phys. Rev., 163: 1470-8(Nov. 25, 1967). (UCRL-11926(Rev.)).

The polarization parameter $P(\theta^*)$ was measured at beam energies of 310, 400, 500, 600, and 700 MeV over the range in the c.m. scattering angles 30 deg $\leq \theta^* \leq$ 150 deg to an accuracy of typically $\pm$0.03 for pn scattering, and $\pm$0.02 for pp scattering. A polarized proton beam was scattered from an unpolarized target—deuterium for quasifree pn and pp measurements, hydrogen for free pp measurements—and both of the outgoing nucleons from the (quasi-) elastic scatter were detected by an array of 27 scintillation counters in multichannel coincidences. It was found that $P(\theta^*)$ for pp scattering can be approximated by A $\sin\theta^* \cos\theta^*$, where A varies from $-$0.25 at 310 MeV to $-$0.4 at 700 MeV in this range. A comparison of $P(\theta^*)$ for free and quasifree pp scattering reveals good agreement between the two. (auth)

5504 SEARCH FOR THE RESONANCE δ^+, OF MASS 960 MeV IN THE REACTION $p + p \rightarrow d + \delta^+$. Banner, M. (CEN, Saclay, France); Cheze, J.; Hamel, J. L.; Marel, G.; Teiger, J.; Zsembery, J.; Chavanon, P.; Crozon, M.; Rangan, L. K. Phys. Lett., 25B: 569-71(Nov. 13, 1967).

A missing mass experiment of the reaction $p + p \rightarrow d + \delta^+$ shows no evidence for the existence of a boson around 960 MeV. (auth)

5505 MEASUREMENT OF THE R PARAMETER AND THE PHASE SHIFT ANALYSIS OF THE pp SCATTERING AT 600 MeV. Golovin, B. M.; Zulkarneev, R. Ya.; Kiselev, V. S.; Medved', S. V.; Nikanorov, V. I.; Pisarev, A. F.; Semashko, G. L. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 804-8(Oct. 1967). (In Russian).

The R parameter of the triple scattering of protons with energy 605 MeV on protons is measured by means of the spark chambers controlled by the scintillation counters. The phase shift analysis of the experimental data on the pp-scattering near 600 MeV is carried out. (auth)

Strong (Meson-Induced)

5506 (INR-P-819/VI) NOTE ON THE AZIMUTHAL ASYMMETRY OF THE SECONDARY PARTICLE EMISSION IN A HIGH ENERGY NUCLEAR REACTION. Balcer, E.; Siemiarczuk, T.; Zielinski, P. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 12p. Dep.

The azimuthal asymmetry in a class of secondaries in the 780 interactions of 9 GeV negative pions with xenon nuclei is observed. The observed asymmetry is correlated with the previously established occurrence of the p-p final state interaction in the secondary particle emission. (auth)

5507 FORMATION OF RESONANT STATES IN $K^-p \rightarrow \bar{K}N$ BETWEEN 780 AND 1220 MeV/c. Armenteros, R. (CERN, Geneva); Ferro-Luzzi, M.; Leith, D. W. G. Nucl. Phys., B3: 592-600(1967).

$K^-p \rightarrow \bar{K}^0 n$, $K^-p \rightarrow K^-p$ and K^-p total cross section data are analyzed in terms of resonant and nonresonant partial wave amplitudes. Results are given on resonance formation in the mass region 1.7 to 1.9 GeV. (auth)

5508 SPALLATION HYPERNUCLEI PRODUCED BY 6 GeV/c K^- MESONS. Evans, D. A. (Oxford Univ. Univ. of California, Riverside); Goodhead, D. T. Nucl. Phys., B3: 441-63(1967).

The production of short-range ($\leq$10 μm) hypernuclei from heavy emulsion nuclei by 6 GeV/c K^- mesons is studied on the basis of the spallation model. Monte Carlo calculations are made to simulate the process and the calculated results compared with experimental data. It is concluded that for this incident K^- beam the main contributor to the momentum of the spallation product is the randomly directed component of the momentum from the cascade process, P_{casc}. The residual momentum due to the evaporation P_{evap} plays only a secondary role. However, the evaporation determines

the mass of the spallation product and in this way can significantly affect the range of the product. Owing to the major role played by the cascade stage it is necessary that, if the spallation model is to be effective, the cascade stage of the calculations must be followed through in much greater detail than has been attempted to date. The wide range of masses of spallation hypernuclei from high-energy interactions is relevant to the attempts to use decays of these hypernuclei to measure the well depth of the Λ-hyperon in nuclear matter. (auth)

5509 STRANGE-PARTICLE PRODUCTION IN π^-p INTERACTIONS FROM 1.5 TO 4.2 GeV/c. I. THREE-AND-MORE-BODY FINAL STATES. Dahl, Orin I.; Hardy, Lyndon M.; Hess, Richard I.; Kirz, Janos; Miller, Donald H. (Univ. of California, Berkeley). Phys. Rev., 163: 1377-1429(Nov. 25, 1967). (UCRL-16978).

The π^-p interactions were investigated from 1.5 to 4.2 BeV/c in the Lawrence Radiation Laboratory's 72-in. hydrogen bubble chamber. The procedures for identifying and analyzing the reactions involving strange-particle production, and the results obtained on three- and more-body final states are described. The analysis is based on 890,000 photographs, on which 50,000 strange-particle events were found. Cross sections for the constrained final states are presented as a function of the beam momentum. The peripheral production of low-lying resonances is found to be the outstanding feature of the reactions. Dalitz plots and their projections are shown for the three-body final states. Production of $Y_0^*(1405)$, $Y_0^*(1520)$, $Y_0^*(1815)$, $Y_1^*(1385)$, $K^*(890)$, $K^*(1440)$ is observed, as well as the $K\bar{K}$ decays of the A_2 and the φ meson. Cross sections and angular distributions for production and decay of these resonances are presented. The results concerning the $K^*(890)$ are compared with absorption-model predictions. Effective-mass distributions for particle pairs and triplets are given for the four-body final states. In these states the D and the E meson and simultaneous Y^*K^* production are also seen. Evidence concerning the quantum numbers of the A_2, the D, the E, and the $K^*(1440)$ is discussed. The behavior of the $K\bar{K}$ system near threshold is examined. A small amount of Ξ production is observed, and the $\Xi^*(1530)$ is also seen. (auth)

5510 STRANGE-PARTICLE PRODUCTION IN π^-p INTERACTIONS FROM 1.5 TO 4.2 GeV/c. II. TWO-BODY FINAL STATES. Dahl, Orin L.; Hardy, Lyndon M.; Hess, Richard I.; Kirz, Janos; Miller, Donald H.; Schwartz, Joseph A. (Univ. of California, Berkeley). Phys. Rev., 163: 1430-40(Nov. 25, 1967). (UCRL-17217).

The reactions $\pi^-p \to \Lambda K^0$, Σ^0K^0, and Σ^-K^+ in the 1.5- to 4.2-BeV/c momentum range were studied in the Lawrence Radiation Laboratory's 72-in. hydrogen bubble chamber. The total cross sections for the three reactions decrease as $E^{-3.6}$, $E^{-3.3}$, and $E^{-0.3}$, respectively. The differential cross sections are presented at 11 beam momenta. A peripheral peak is the dominant feature of the reactions $\pi^-p \to \Lambda K^0$ and Σ^0K^0, for which K^* exchange is allowed, but no such peaking is seen in $\pi^-p \to \Sigma^-K^+$. An exponential fit to the momentum-transfer distributions in the peripheral region yields slope parameters in the 6- to 10-$(BeV/c)^{-2}$ range. The differential cross sections for $\pi^-p \to \Lambda K^0$ and Σ^-K^+ show peaking for forward production of hyperons in the c.m. system, to which baryon exchange is expected to contribute. The angular distribution of the Λ polarization in $\pi^-p \to \Lambda K^0$ is presented. (auth)

5511 REACTION $K^-p \to \Lambda\eta$ FROM 1.2 TO 1.7 GeV/c. Flatte, Stanley M.; Wohl, Charles G. (Univ. of California, Berkeley). Phys. Rev., 163: 1441-6(Nov. 25, 1967).

Total and differential cross sections of the reaction $K^-p \to \Lambda\eta$ have been determined for incident K^- lab momenta between 1.2 and 1.7 BeV/c. No striking resonance formation in the direct channel is seen; in particular, the $Y_0^*(2100)$ decays not more than 3% via the $\Lambda\eta$ channel. A prominent forward peak in the differential cross sections indicates some crossed-channel meson-exchange activity. The branching ratio $\Gamma(\eta \to \text{neutrals})/\Gamma(\eta \to \pi^+\pi^-\pi^0)$ is 3.6 ± 0.6. (auth)

5512 DETERMINATION OF THE SPIN AND PARITY OF THE $Y_1^*(1660)$. Eberhard, P.; Pripstein, M.; Shively, F. T. (Univ. of California, Berkeley). Phys. Rev., 163: 1446-50 (Nov. 25, 1967).

Experimental evidence is reported for a spin of ½ and negative parity for the $Y_1^*(1660)$, based on a study of a production experiment, $K^-p \to Y_1^*(1660)^+ + \pi^- \to \Sigma^+\pi^+\pi^-$, in the region 2.1 to 2.7 GeV/c. The spin was determined by an Adair analysis of the $Y_1^*(1660)$ decay angular distributions, and the parity determination was based on a Dalitz-Miller type of analysis of the $Y_1^*(1660)$ decay into $\Sigma\pi\pi$, involving three interfering processes and some background. (auth)

5513 REACTION $\pi^-p \to \pi^-\pi^+n$ AT 8 GeV/c. Poirier, J. A. (Univ. of Notre Dame, Ind.); Biswas, N. N.; Cason, N. M.; Derado, I.; Kenney, V. P.; Shephard, W. D.; Synn, E. H.; Yuta, H.; Selove, W.; Ehrlich, R.; Baker, A. L. Phys. Rev., 163: 1462-70(Nov. 25, 1967).

Approximately 26,500 two-prong events were measured and analyzed by the Notre Dame and Pennsylvania groups, independently. From these analyses, 2421 events of the reaction $\pi^-p \to \pi^-\pi^+n$ were obtained. The predictions of one-particle-exchange models with and without absorptive effects are compared with our data for the production and decay of the ρ^0 and the f^0. The recently discovered g^0 meson was also observed. The cross sections for ρ^0, f^0, and g^0 production are also given. (auth)

5514 REACTION $\pi^+p \to \Sigma^+K^+$ AT 3.23 GeV/c. Kofler, R. R.; Hartung, R. W.; Reeder, D. D. (Univ. of Wisconsin, Madison). Phys. Rev., 163: 1479-81(Nov. 25, 1967). (COO-881-110).

The reaction $\pi^+p \to K^+\Sigma^+$ was studied at 3.23 GeV/c in a hydrogen bubble chamber. The angular distribution is strikingly similar to that of the $\pi^-p \to \pi^0n$ reaction near this energy. A large polarization of the Σ hyperon is also observed. (auth)

5515 OBSERVATION OF THE REACTION $\pi^-p \to p\bar{p}n$ AT 8 GeV/c. Andrews, J. W.; Biswas, N. N.; Cason, N. M.; Derado, I; Kenney, V. P.; Poirier, J. A.; Shephard, W. D. (Univ. of Notre Dame, Ind.). Phys. Rev., 163: 1502-9(Nov. 25, 1967).

The reaction $\pi^-p \to p\bar{p}n$ at 8 GeV/c was observed with a cross section of 97 ± 26 μb. Because this reaction does not possess a distinctive topology in the bubble chamber which could distinguish it from the more frequent two-prong final states involving a nucleon and some number of pions, tests were performed independent of the kinematic fitting process to confirm the presence of this reaction. These tests made use of the δ rays and secondary interactions produced by the negative tracks of our events. The possibility of various forms of contamination was also investigated. The final sample of events contains about 60% $p\bar{p}n$ final states and 40% background. (auth)

5516 INVESTIGATION OF THE A_2-MESON PROPERTIES IN THE π^-p INTERACTION AT 3.25 GeV/c. Vetlitskii, I. A.; Vladimirskii, V. V.; Grigor'ev, V. K.; (and others). (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 6: 795-803(Oct. 1967). (In Russian).

There were 160,000 photographs obtained with the 55-cm hydrogen bubble chamber on the π^--meson beam with momentum (3.25 ± 0.02) GeV/c. From these, 7,000 four-prong events were selected and analyzed. In the effective mass distribution for the $\pi^+\pi^-\pi^-$-system the events within the range of the A_2-meson were selected and studied in order to determine the spin and the parity of the A_2-meson by means of various methods. The $A_2 \to \pi\eta$ decay in the reaction $\pi^-p \to p\pi^+\pi^-\pi^-\pi^0$ was also studied. (auth)

5517 DETECTION OF THE $\omega^0 \to \pi^0\gamma$ DECAY FOR π^- MESONS PRODUCED BY THE 9 GeV/c MESONS IN THE π^--Xe INTERACTIONS. Kanarek, T. I.; Loskevich, E.; Martynov, A. S.; Nichiporuk, B.; Strugal'skii, Z. S.; Semashko, G. L.; Semyarchuk, T.; Tskreis, K. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 786-94(Oct. 1967). (In Russian).

The 3γ decays of neutral bosons were investigated by means of the 24-liter xenon bubble chamber exposed to the 9 GeV/c π^- beam. The $\omega^0 \to \pi^0 + \gamma$ decay is detected directly after the presence of the statistically definite peak in the $\pi^0\gamma$ state effective mass distribution. The upper bound to the branching of two radiational decays of ω^0 is found: $R = W(\omega^0 \to \gamma + \gamma + \gamma)/W(\omega^0 \to \pi^0 + \gamma) \leq 0.2 \pm 0.15$. The lower bound to the ω^0-production cross section for the π^-−Xe interaction is also found: $\sigma_{Xe}(\omega^0) > 7.1 \pm 1.5$ mbarn. (auth)

Particle Interactions and Properties (Theoretical)

General

5518 (AED-C-23-18) HIGH ENERGY PHYSICS INDEX. Volume 5, Number 10(4920-5616). Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1967. 248p. Dep.

The high-energy physics index presented is divided into categories of experimental physics, including general, weak, electromagnetic, and strong interactions, strange particles, accelerators, and methods and instruments; and theoretical physics including general, weak, electromagnetic, and strong interactions, strange particles, symmetry principles, and field theory. Also author, report number, and subject indices are included. (J.F.P.)

5519 (NYO-3399-140) RESEARCH PROGRAM IN ELEMENTARY PARTICLE THEORY. Progress Report for the Period Ending November 30, 1967. (Syracuse Univ., N. Y. Dept. of Physics). Contract AT(30-1)-3399. 40p. (SU-1206-140). Dep. CFSTI.

Significant contributions were made to the hypotheses which underlie the application of current algebras to elementary particle physics, superconvergent dispersion relations, and the use of infinite component wave equations in describing the spectrum and properties of strongly interacting particles. Also the investigation of the representation theory of noncompact groups and their application to dynamical systems was pursued. Further major areas of interest were mass splitting theorems for Lorentz invariant systems, the use of associative algebras to obtain particle spectra, and an exhaustive investigation of the implications of a universal theory of weak, electromagnetic and strong interactions. (J.F.P.)

5520 (NYO-3829-18) HIGH ENERGY PHYSICS AT THE UNIVERSITY OF PITTSBURGH. Progress Report, March 1–December 1, 1967. (Pittsburgh Univ., Pa.). Nov. 1967. Contract AT(30-1)-3829. 17p. Dep. CFSTI.

The research accomplished during the period from March 1, to December 1, 1967, is reviewed. This research covers current algebra, the $\pi + \pi$ interaction in K_{e4} decay, fundamentals of quantum electrodynamics, quantum electrodynamical calculations in external fields, symmetry in classical systems, and the quark model. Also crossing matrices and relativistic Hamiltonian particle mechanics are discussed. (J.F.P.)

5521 COMPOSITE SYSTEM WITH LINEAR TRAJECTORY. Ito, Daisuke; Mori, Kenju; Carriere, Edward (Louisiana State Univ., Baton Rouge). Progr. Theor. Phys. (Kyoto), 38: 737-8 (Sept. 1967).

Another example of a composite system the mass of which is a linear function of the angular momentum is shown. A system of heavy Dirac particles described by the Bethe–Salpeter equation is considered. These particles are supposed to be bound by a spring force. (J.F.P.)

5522 PARASTATISTICS AND UNIFIED THEORY OF IDENTICAL PARTICLES. Landshoff, P. V.; Stapp, Henry P. (Univ. of California, Berkeley). Contract W-7405-eng-48. Ann. Phys. (N.Y.), 43: 72-92(1967). (UCRL-17310).

The simplest parafermi model is shown to be equivalent to a theory with two types of ordinary fermions that are dynamically indistinguishable. Also, a unified theory of identical particles is proposed that encompasses theories arising both from the permutation-symmetry approach of the first-quantized theory and from the parastatistics commutation-relation approach of second-quantized theory. Using this theory cluster properties are shown to be compatible with parastatistics. (auth)

5523 HIGH-ENERGY SCATTERING. Barger, Vernon D.; Cline, David B. Sci. Amer., 217: No. 6, 77-9; 82-4; 89-91 (Dec. 1967).

The general features of a typical high-energy scattering experiment are explained. Some fundamental theoretical ideas that provide the framework within which physicists study the collisions and the structure of the particles are discussed. (L.B.S.)

5524 NEW FOUNDATION FOR PARTICLE THEORY. Schwinger, Julian (Harvard Univ., Cambridge). pp 179-93 of Proceedings of the Fifth Annual Eastern Theoretical Physics Conference, Brown University, Providence, November 25–26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-661129.

The ideas behind the construction of a new phenomenological foundation of particle theory based on the source concept are presented. (L.B.S.)

5525 RELATIONSHIPS BETWEEN THE MASSES OF SUBATOMIC PARTICLES. Lewis, D. T. (Lab. of Government Chemist, London). Nature (London), 216: 573-4(Nov. 11, 1967).

The most reliable experimental figures for the rest masses of the known subatomic particles have recently been listed (Rosenfeld et al., Rev. Mod. Phys. 39: 1 (1967); Zeldovich, Atom. Energy Rev. 5: 1 (1967)), and it would appear that the changes in the individual masses of these particles can be explained very simply by postulating the ubiquitous existence of a small particle of mass equivalent to ~26 MeV. The author refers to this minute particle as a "tamaid." It is shown that the masses of the known neutral subatomic particles can be calculated with considerable exactitude if it is assumed that each particle contains a π^0 meson (134.97 MeV) associated with an integral number, n, of neutral "tamaid" particles of mass $t^0 = 25.95$ MeV. The "magic number" n has typical quantum characteristics. Calculated values for the individual rest masses of mesons, neutrons and baryons, expressed in MeV, are shown to agree well with experimental figures. It can be argued that the neutron consists of a π^0 meson associated with 31 "tamaids," either as a static conglomerate or having the minor masses rotating in individual quantised orbits, the outward centrifugal forces being balanced by equivalent inward forces produced by mass interactions. Gravitational forces could become very large if the electromagnetic shape of the atomic particles were such as to permit the close approach of centres of mass. With positively or negatively charged subatomic particles the possibility cannot be ignored of the existence of "tamaids" of $t^\pm$ type having masses of the order of 25.95 MeV. The existence of quantum numbers for hypercharge, isotopic spin, angular momentum and parity also needs to be considered. It could be assumed that $\pi^\pm$ mesons (139.577 MeV) form the nuclei of charged subatomic particles, with similar n numbers. Some relevant data are tabulated for such particles. It is noted that no subatomic particles are known for the range n = 1 to 13, and this is discussed. The "tamaid" theory is also briefly discussed in relation to the quark theory. (UK)

5526 SYMPOSIA ON THEORETICAL PHYSICS. VOLUME 3. Lectures Presented at the 1964 Summer School of the Institute of Mathematical Sciences, Madras, India. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967. 189p. $9.50.

The book includes seven lectures. Separate abstracts were prepared for six lectures. The other paper contained a discussion of a class of non-Markovian processes and its application to the theory of shot noise and Barkhausen noise. (J.F.P.)

For abstracts of individual papers see: 5527, 5577, 5621, 5634, 5635, and 5877.

5527 THEORIES OF PARTICLES OF ARBITRARY SPINS. Venkatesan, K. (MATSCIENCE, Madras). pp 75-97 of Symposia on Theoretical Physics. Vol. 3. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

The discussion of arbitrary-spin particle theories covers relativistic wave equations including the Dirac, Fierz, Pauli, Belinfante, Rarita, and Schwinger, the matrix-algebraic approach to relativistic wave equations, Feynman rules for any spin, and arbitrary spins and the S-matrix approach. (J.F.P.)

Electromagnetic

Refer also to abstracts 5550 and 5696.

5528 (JINR-E2-3558) CHARGE-DIVERGENCE COMMUTATOR. Micu, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 8p. Dep.

From the commutator of a charge with the divergence of the corresponding current an equation for the electromagnetic form factor of the π-meson is obtained. This equation gives a correct value for electromagnetic self-energy and a wrong magnitude and sign for mean square radius. Taking into account ω-meson intermediate states the result is not improved. (auth)

5529 REMARKS ON ELECTROMAGNETIC MASS DIFFERENCES. Konno, Kimiaki (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 38: 738-40(Sept. 1967).

The electromagnetic mass differences of the baryon octet and decuplet are considered from the standpoint of the extended Sakata model, where the symmetry-breaking of unitary multiplets and isomultiplets due respectively to the $\Lambda - (np)$ and the $n - p$ mass difference is supposed. It is assumed that the electromagnetic mass difference is caused additively by a single index 2 and an antisymmetric index pair which has equivalent properties of a contragredient index $\bar{2}$. (J.F.P.)

5530 EXACT TREATMENT OF $(\pi + \pi \rightleftharpoons N + \bar{N})$ AMPLITUDE AND ELECTROMAGNETIC STRUCTURE OF NUCLEON. Furuichi, Susumu (Rikkyo Univ., Tokyo); Kanada, Hiroyuki; Watanabe, Keiji. Progr. Theor. Phys. (Kyoto), 38: 636-52(Sept. 1967).

The isovector part of the electromagnetic form factor of the nucleon is investigated starting from an exact treatment of the $(\pi + \pi \rightleftharpoons N + \bar{N})$ amplitude. It is shown that the experimental data can be reproduced very well (at least for $0 > t \gtrsim -50\mu^2$) if the contributions from both correlating and un-correlating two-pion states are rightly included. The mass shift of the ρ-resonance is realized as a result of the coexistence of the correlated and the uncorrelated two-pion contributions. It is also shown that $I = L = 1$ helicity amplitude of the $(\pi + \pi \rightleftharpoons N + \bar{N})$ process can be determined by the investigation of the form factors. Related problems, such as the spectral functions of the isovector form factors and the estimate of effective $\rho N\bar{N}$ coupling constants, are also discussed. (auth)

5531 EXCHANGE MAGNETIC MOMENTS OF BARYONS AND THE QUARK MODEL. Kobayashi, Tsunehiro (Waseda Univ., Tokyo); Konno, Kimiaki. Progr. Theor. Phys. (Kyoto), 38: 671-80(Sept. 1967).

The contribution of the exchange currents to the magnetic mo-

ments of baryons is studied within the framework of the quark model. It is suggested that the exchange current effect may be responsible for the deviation of the SU(6) symmetric predictions from the experimental data. It is shown that the effect shifts the magnetic moments of proton, neutron, Λ, and Σ^+, and of the M1 transition between the proton and N^*_{33} toward a good direction. It is also found that the additivity properties of the quarks in the baryon structure are still valid in the electromagnetic interaction even in the presence of the exchange currents, because their contributions are not very large. (auth)

5532 COMPOSITE MODELS OF HADRONS AND HIGH ENERGY PHOTOPRODUCTION OF VECTOR MESONS. Morita, Katsusada (Kyoto Univ., Japan). Progr. Theor. Phys. (Kyoto), 38: 681-704(Sept. 1967).

The possibility that high-energy photoproduction of neutral vector mesons can be used to test the validity of composite models is discussed. Branching ratios for photoproduction of neutral vector mesons are calculated in terms of diffraction models from the view that hadrons are composite particles in the sense that they consist of some more fundamental objects. It is found, as far as the investigations are concerned, that the quark and the three-triplet models are better candidates than others, but it is impossible to distinguish these models. Leptonic decay modes of neutral vector mesons are discussed along the same lines. (auth)

5533 INDEPENDENT ELECTRON POSITRON PAIR PRODUCTION EVENTS AND ENERGY LOSS. Gilson, J. G. (London Univ.). Fortschr. Phys., 15: 537-49(1967).

By defining electron positron pair production events in such a way that they are statistically independent, it is possible to introduce a graphical representation of "events." This definition is then used to find the energy lost by an external field in the form of induced pairs when the induced current is a nonlinear functional of the driving field. (auth)

5534 FORM FACTORS AND VERTEX AMPLITUDES IN ELASTIC ELECTRON–NUCLEON SCATTERING. Kessler, Paul (College de France, Paris). Cah. Phys., 21: 113-16(Mar.-Apr. 1967). (In French).

The form factors are defined as coupling coefficients which appear in the interaction Hamiltonian, and an argument given by Barnes, who showed that the usual expression for the γNN current is not absolutely unique, is studied. It is concluded that the vertex amplitudes should be adopted as physically significant quantities in elastic e + N scattering. This conclusion can also be extended to other electromagnetic processes. (J.F.P.)

5535 ELEMENTARY PARTICLE INTERACTIONS IN LIGHT-DIMENSIONAL SPACE. Duong Van Phi (Moscow State Univ.). Cah. Phys., 21: 101-12(Mar.-Apr. 1967). (In French).

The S-matrix is found in the 8-dimensional space obtained by combining the isotopic and Minkowskian space-time. The contour integrations are carried out in the complex plane of the internal energies, while the calculated matrix elements corresponding to Feynman's diagrams are all finite. By considering electromagnetic interaction, some scattering cross-sections, in value close to earlier results of the usual theory, are obtained. (auth)

5536 VIOLATION OF CP INVARIANCE AND THE ELECTRIC DIPOLE MOMENT OF THE NEUTRON. Nishijima, K.; Swank, L. J. (Univ. of Illinois, Urbana). Nucl. Phys., B3: 565-8(1967).

On the basis of the model of CP violation recently proposed, the static electric dipole moment of the neutron is calculated. The result is $|\mu_{ed}/e| = |D| \approx 9 \times 10^{-22}$ cm. (auth)

5537 ANALYSIS OF PION PHOTOPRODUCTION IN THE SECOND RESONANCE REGION. Chau, Y. C. (Glasgow Univ.); Dombey, Norman; Moorhouse, R. G. Phys. Rev., 163: 1632-45(Nov. 25, 1967).

A phenomenological analysis is made of the pion photoproduction data in the energy range $535 < E_\gamma < 850$ MeV. The analysis is based on the pion-nucleon phase-shift analyses using a generalized isobar model. The Watson theorem for the elastic pion-nucleon partial waves is imposed. η photoproduction data in the same energy range is also analyzed using an effective range expansion of the K matrix. The nucleon-isobar electromagnetic couplings are determined. (auth)

5538 SUPERCONVERGENCE, COMPTON SCATTERING, AND RADIATIVE DECAYS. Chanda, Rajat (Univ. of Rochester, N. Y). Phys. Rev., 163: 1627-8(Nov. 25, 1967). (UR–875-202).

Sum rules for Compton scattering from $J^P = 1^-$ and $\frac{3}{2}^+$ particles are derived using methods similar to that of Pagels and Harari. With appropriate pole approximation, several relations involving radiative decay widths of vector mesons are obtained. (auth)

5539 ELECTROPRODUCTION OF π MESONS AT HIGH ENERGY AND LARGE MOMENTUM TRANSFER. Vik, Robert C. (Univ. of California, San Diego, La Jolla). Phys. Rev., 163: 1535-44(Nov. 25, 1967). (UCSD-10-P-10-25).

The inelastic scattering of an electron by a nucleon, accompanied by creation of a single π meson (pion electroproduction) is considered as a function of k^2, the square of the three-dimensional momentum transferred from the electron to the final pion-nucleon system. At energies high enough that the pion-nucleon center-of-mass energy is above the region of the N*(1238) resonance, no complete cross-section calculation exists, largely because the presence of inelastic channels makes the calculation difficult. However, the effect of an important set of one-particle-exchange diagrams can be evaluated, and it is proposed that they provide a way of examining the qualitative behavior of the electroproduction cross section as a function of k^2. The cross section in several partial waves, due to these diagrams, are evaluated and are compared with published experimental results at several energies. It is found that the S_{11} and P_{11} partial waves are likely to be important at large values of k^2 and at high energies. Furthermore, the dependence of the cross section on k^2 in these partial waves is qualitatively like the dependence indicated by the experiments at 1512 MeV pion-nucleon center-of-mass energy. (auth)

5540 SMALL-ANGLE PHOTOPRODUCTION AND CONSPIRACY. Frautschi, Steven; Jones, Lorella (California Inst. of Tech., Pasadena). Phys. Rev., 163: 1820-5(Nov. 25, 1967). (CALT–68-132).

In any reaction of the class $\pi + B \to V + B$ or $V + B \to \pi + B$, nonconspiring amplitudes with a meson helicity change $(h_\gamma - h_\pi \neq 0)$ exhibit a dip at small angles. Normally, this would simply mean that the zero-helicity-change amplitude dominates forward production. But in photoproduction, since the photon has no longitudinal component, there is no zero-helicity-change amplitude, and in the absence of conspiracy a forward dip will appear in the differential cross section. When conspiracy is present, the dip does not appear. Thus, forward photoproduction provides a good test for conspiracy. (auth)

5541 CURRENT ALGEBRA AND THE DECAY MODES $\eta \to \pi^+\pi^-\pi^0\gamma$ AND $\eta \to \pi^0\gamma\gamma$. Sarker, A. Q. (Univ. of Islamabad, Rawalpindi, Pakistan. Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev. Lett., 19: 1261-4(Nov. 20, 1967).

The decay rate of $\eta \to \pi^+ + \pi^- + \pi^0 + \gamma$ is related to that of $\eta \to \pi^0 + \gamma + \gamma$ by using the technique of the current algebra, the partial conservation of axial-vector currents, and the equal-time commutation relation between the axial-vector currents. The decay rate is predicted to be $R' = \Gamma(\pi^+\pi^-\pi^0\gamma)/\Gamma(\pi^0\gamma\gamma) \simeq 0.42\%$. Introducing a correction for the $X^0-\eta^0$ mixing gives $R' \simeq 0.28\%$. The calculated ratios, being well within experimental upper limits, indicate that because of the kinematic dependence of the matrix element on the pion momentum the final-state interactions between pions in the decay process $\eta \to \pi^+\pi^-\pi^0\gamma$ may perhaps be ignored. (L.B.S.)

5542 HADRONIC ELECTROMAGNETIC CURRENT AND NEUTRAL VECTOR MESONS. Lee, T. D. (Columbia Univ., New York). pp 101-11 of Proceedings of the Fifth Annual Eastern Theoretical Physics Conference, Brown University, Providence, November 25–26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-661129.

The concept of vector meson dominance of the electromagnetic phenomena is studied from the viewpoint of a Lagrangian field theory. In particular, it is investigated, within the context of the local field theory, whether the entire hadronic electromagnetic current operator can be identified with a linear combination of the known neutral vector meson fields. Gauge invariance, the renormalization problem, $\phi-\omega$ mixing, and charge renormalization are treated. (L.B.S.)

5543 SUM RULES FOR DEUTERON COMPTON SCATTERING. Lewin, K.; Robaschik, D. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 25B: 522-3(Oct. 30, 1967).

For γd forward scattering a family of sum rules is obtained. Two of them are sum rules for the anomalous magnetic moment and the electric quadrupole moment of the deuteron. (auth)

5544 THRESHOLD VECTOR DOMINANCE HYPOTHESIS AND COMPTON SCATTERING OF ISOVECTOR PHOTONS BY PIONS. De Baenst, P.; Pestieau, J. (Univ., Louvain, Belg.). Phys. Lett., 25B: 515-16(Oct. 30, 1967).

The threshold vector dominance hypothesis proposed by Sakurai is extended to the case of Compton scattering of isovector photons by pions and it is shown that it implies the ρ-dominance model for the pion form factor. (auth)

Weak

Refer also to abstract 5562.

5545 NEUTRINO-PRODUCTION OF ALL BARYONIC STATES. I. Kessler, Paul; Malamant, Alexandre (College de France, Paris). Cah. Phys., 21: 117-24(Mar.-Apr. 1967). (In French).

With the help of the traceless Feynman diagram calculation method recently established the differential cross sections for all processes $\nu + N \rightarrow 1^- + N'$, $\bar{\nu} + N \rightarrow 1^+ + N'$, $1^- + N \rightarrow \nu + N'$, $1^+ + N \rightarrow \bar{\nu} + N'$, where N' is a (nonstrange or strange) baryon state of any spin and parity. The general result is given as a function of eight form factors (six only in the case of spin $\frac{1}{2}$). Numerical estimates of those form factors on the basis of various theories, and resulting numerical predictions for neutrino-production of baryon resonances will be given at a later stage. (auth)

5546 ANALYSIS OF K_{e4} DECAY, EVIDENCE FOR A VECTOR CURRENT AND ITS CONSEQUENCES. Berends, F. A.; Donnachie, A.; Oades, G. C. (CERN, Geneva). Nucl. Phys., B3: 569-91(1967).

K_{e4} decay data are analyzed under various assumptions about the behavior of the s-wave π-π phase shift, and the s-wave scattering length and the axial vector form factors are evaluated. An interesting feature of the analysis is the possible existence of a large vector current term. The form factor is determined and SU(3) (with vector octet dominance) used to relate this to η and η' decay. If taken literally, the results obtained are not compatible with the experimental evidence on these decays. However, the errors on the vector form factor are so large that the discrepancy is, at worst, not much more than two standard deviations. There are also several theoretical loop-holes which are discussed. The p-dominance model is used to calculate the vector form factor, and the theoretical value is found to be of the order of two standard deviations below the experimental result. (auth)

5547 REGULARIZATION IN WEAK INTERACTION THEORY AND THE FEINBERG-PAIS PERATIZATION METHOD. van der Wal, S. G.; Tolhoek, H. A. (Univ. of Groningen, Netherlands). Nucl. Phys., B3: 511-46(1967).

Weak interaction theory with W-intermediate bosons is considered using perturbation expansions and regularized propagators. A method of regularization is used in which the sum of ladder diagrams can be represented explicitly in terms of Bessel functions (in a certain approximation) studying the problem of lepton–lepton scattering. In this way convergence problems of the sum and the behavior for analytic continuation in the regulator parameter α (of the dimension of a length) can easily be studied in detail. It turns out that the Feinberg-Pais peratization method corresponds to analytic continuation to a value zero of the parameter α, but that major physical objections exist against this limit transition. (auth)

5548 Λ-N WEAK-INTERACTION, UNITARY SYMMETRY, AND NUCLEON–NUCLEON SCATTERING PHASE SHIFTS. Panchapakesan, N. (Univ. of Chicago). Contract AT(11-1)-264. Ann. Phys. (N.Y.), 45: 172-85(1967). (COO-264-381).

The weak interaction process $\Lambda N \rightarrow NN$ is studied under the assumption that the weak Hamiltonian transforms like scalar (for the parity-conserving part) and pseudoscalar (for the parity-violating part) densities which behave like the sixth (λ_6) and seventh (λ_7) components of an octet, respectively, under the SU(3) transformations. The six possible transition amplitudes can thus be expressed as products of a weak transition and a strong scattering amplitude. The scattering amplitude is expressed in terms of five invariant amplitudes which are related to the N–N scattering phase shifts. The ratio D^C/F^C for parity conserving weak transition is required to be equal to –3 to suppress the parity-conserving amplitudes. All the other parameters of the weak interaction are known from the weak pionic decay of baryons. The resulting rates for the transitions agree very well with regard to both relative and absolute magnitudes with the rates determined from the study of hypernuclear decays. (auth)

5549 STRONG INTERACTIONS AS A POSSIBLE MEDIATOR OF WEAK INTERACTIONS. Halpern, M. B. (Univ. of California, Berkeley). Phys. Rev., 163: 1611-13(Nov. 25, 1967).

Assuming current algebra and using Bjorken's methods, it is argued that inclusion of the strong interactions to all orders will almost certainly not remove the nonrenormalizability of the weak interactions. (auth)

5550 INEQUALITY FOR BACKWARD ELECTRON- AND MUON–NUCLEON SCATTERING AT HIGH MOMENTUM TRANSFER. Bjorken, J. D. (Stanford Linear Accelerator Center, Calif.). Phys. Rev., 163: 1767-9(Nov. 25, 1967). (SLAC-PUB–316).

From a sum rule for backward ν-p scattering, valid only in the limit of large four-momentum transfer q^2, an inequality is obtained for backward e-p inelastic scattering which depends upon the commutator of space components of isospin currents. Given chiral U(6) × U(6) current algebra, the total backward scattering at fixed large q^2 is predicted to be at least as great as that from a point Dirac particle with charge $\pm\frac{1}{2}e$. (auth)

5551 EXTREMUM RELATIONSHIP FOR LEPTON MASSES. Shaffer, R. A. (Lehigh Univ., Bethlehem, Pa.). Physics, 3: 161-4(Aug. 1967).

It is suggested that the muon and electron have mass values which maximize the dimensionless quantity Γ/Q (decay rate/Q-value) for classes of meson decays and β decays, respectively. As a consequence, $M_{\Sigma^-} - M_{\Sigma^0}$ is predicted to be 5.2 ± 0.3 MeV. (auth)

5552 RADIATIVE PION ABSORPTION AND MUON CAPTURE. Pietschmann, H. (Univ., Bonn); Fulcher, L. P.; Eisenberg, J. M. Phys. Rev. Lett., 19: 1259-61(Nov. 20, 1967).

The hypotheses of partially conserved axial-vector currents and of current commutators are used to prove a direct relationship between the radiative absorption of soft pions and muon capture in nuclei without recourse to the impulse approximation or assumptions concerning nuclear structure. (auth)

5553 MODEL OF LEPTONS. Weinberg, Steven (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 19: 1264-6(Nov. 20, 1967). (MIT–2098-377).

A model is described in which the symmetry between the electromagnetic and weak interactions is spontaneously broken, but in which the Goldstone bosons are avoided by introducing the photon and the intermediate boson fields as gauge fields. Renormalization of the model is discussed. (L.B.S.)

5554 T-ODD CORRELATION IN THE K^0_{l3} DECAY AND THE PION ELECTROMAGNETIC FORM FACTOR. Okun', L. B.; Khriplovich, I. B. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 6: 821-7(Oct. 1967). (In Russian).

The polarization of the muon from the K^0_{l3} decay normal to the decay plane and due to the electromagnetic interaction between the muon and the pion is calculated. The magnitude of such an "electromagnetic polarization" depends on the electric radius of the pion and its sign is identical for the decays $K^0 \rightarrow \pi^-\mu^+\nu$ and $\bar{K}^0 \rightarrow \pi^+\mu^-\bar{\nu}$. The same polarizations due to the CP violation have the opposite signs for the two decays. (auth)

5555 NEUTRAL CURRENTS AND THE LIMIT OF APPLICABILITY OF THE WEAK INTERACTION THEORY. Ioffe, B. L.; Shabalin, E. P. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 6: 828-39(Oct. 1967). (In Russian).

On the basis of current algebra it is shown that in some hadron-lepton interactions of the second order in the weak interaction, the strong interactions of hadrons do not cut off the virtual momenta because the effective constant of neutral transitions of the type of $K^0_1 \rightarrow \mu^+\mu^-$ (I) proves to be equal to $(G\Lambda/4\pi)^2$ in the charged intermediate W-boson theory and 8 times as large in the four-fermion interaction theory (Λ — is the cut off momentum due to the weak or electromagnetic interactions). The comparison with the experimental limit for the (I) decay results in $\Lambda \lesssim 100$ GeV in the W-boson theory, that, in its turn, limits the W-boson mass by $m_w \lesssim 8$ GeV if the cut off is due to the electrodynamics of W-bosons. The lower limit on Λ in the W-boson theory follows from $\Delta m(K^0_1 - K^0_2)$. In the four fermion theory the limit on Λ from the (I) decay proves to be $\Lambda \lesssim 30 + 40$ GeV that is too small for the weak interactions to be cut off due to themselves. It is possible that the four-fermion form of the weak interaction exists only at small energies. (auth)

5556 CHARGE ASYMMETRY IN THE DECAY $K^0 \rightarrow \pi^+\pi^-\pi^0$. Zeldovich, B. Ya. Yadern. Fiz., 6: 840-4(Oct. 1967). (In Russian).

The decays of the neutral kaon into the $\pi^+\pi^-\pi^0$ state are discussed in connection with the isospin and the CP parity selection rules. The main point is the estimates of the charge asymmetry R. The expected effects may be detectable in experiments. (auth)

Strong (General)

Refer also to abstracts 5549 and 5630.

5557 SYMMETRIES IN FIRST-APPROXIMATION S-MATRIX THEORY. I. HIGH-ISOSPIN SCATTERING. Neville, Donald E. (Univ. of California, Livermore). Phys. Rev., 163: 1582-90 (Nov. 25, 1967). (UCRL–14771-T; UCRL–14771-T(Pt.1)).

A simple example of a high-isospin system is constructed and verified (in "first approximation"; that is, all contributions to the unitarity relations are dropped except those from the nearest two-body channels, it is assumed that the number of such channels is small, and crossed singularities are approximated by poles) that it satisfies the requirements suggested by an S-matrix theory of strong interactions. The forces producing each particle act through isospin crossing matrix elements of reasonable size, and no crossing matrix element is so large that the force into a direct channel will cause pathologies such as negative-energy bound states or (in Regge theory) trajectories violating the Froissart limit. Strictly speaking, the stability of our example is not completely established, since a complete dynamical calculation is not performed (with some specific choice of spins and cutoff functions), but only the sizes of the relevant isospin crossing matrix elements is studied. It is also shown that a mechanism suggested by the "strong-coupling" model is not suitable for producing high-isospin particles, at least in the low-energy region, because if the model were treated in other than static approximation it would develop negative-energy bound states in the annihilation channel. (auth)

5558 LAGRANGIAN METHOD FOR CHIRAL SYMMETRIES. Wess, J.; Zumino, Bruno (New York Univ.). Phys. Rev., 163: 1727-35(Nov. 25, 1967).

The method of phenomenological nonlinear Lagrangians is described in detail for the case of chiral SU(2) × SU(2). The complete nonlinear Lagrangian is constructed for a theory of pions, nucleons, and vector and axial-vector mesons. The Lagrangian allows a study of the strong and weak interactions of the particles involved. Relations between masses and coupling constants emerge. A model containing only pions and nucleons is also described. Finally, the way to generalize the method to SU(3) × SU(3) is indicated. (auth)

5559 NUMERICAL ANALYSIS OF HADRON TOTAL CROSS SECTIONS IN THE QUARK MODEL. Barnhill III, Maurice V. (Stanford Univ., Calif.). Phys. Rev., 163: 1735-43(Nov. 25, 1967).

The linear parametrization of the hadron-hadron total-scattering cross sections at high energy given by the additive quark model are compared with experiment by a least-squares analysis using several different kinematic assumptions. Expressions for the corrections due to shadowing and double scattering are obtained, and the corrections are shown to be large enough to be important. A nonlinear parametrization obtained from the expression for the shadowing correction is compared with experiment by a least-squares analysis. The agreement is good under two different kinematic assumptions. Agreement is also good using the linear parametrization with the kinematic assumptions of James and Watson. In all cases studied, the amplitude for scattering of the λ quark from a nonstrange quark is significantly lower than the amplitude for scattering of two nonstrange quarks. The amplitude for the scattering of the nonstrange quark and antiquark in an iso-singlet state is both significantly larger and much more energy-dependent than any of the other amplitudes. (auth)

5560 SOME EXTENSIONS OF THE MANY-BODY POTENTIAL MODEL OF QUARK BINDING. Barnhill III, Maurice V. (Stanford Univ., Calif.). Phys. Rev., 163: 1744-7(Nov. 25, 1967).

A model due to Schiff which accounts for the binding of quarks in terms of large, many-body potentials is extended to allow a semi-qualitative discussion of scattering. It is found that, keeping only one-, two-, and three-body forces, the range of the repulsive three-body force must be larger than that of the attractive two-body force. As a result, the hard core in nucleon-nucleon scattering appears naturally. It is observed, however, that the presence of a large, relatively long-range many-body interaction is difficult to reconcile with the high-energy sum rules of Levin and Frankfurt and of Lipkin and co-workers. Finally, some remarks on the possible need to include four-body and higher potentials are included. (auth)

5561 GENERALIZED ALGEBRA OF CURRENTS AND REGGE POLES. Okubo, Susumu (Univ. of Rochester, N. Y.). Physics, 3: 165-80(Aug. 1967).

By using the generalized algebra of currents based upon commutators on the light cone, it is shown that one can re-interpret Regge trajectories in terms of our generalized commutators. In this way, the correspondence between our theory and Regge's is one to one, and many results of Regge poles can be derived without invoking the concept of complex angular momentum. Besides, many sum rules for the high energy scattering cross sections are obtained. (auth)

5562 VECTOR MESON DOMINANCE AND CURRENT ALGEBRA. Sakurai, J. J. (Univ. of Chicago). pp 81-99 of Proceedings of the Fifth Annual Eastern Theoretical Physics Conference, Brown University, Providence, November 25-26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-661129.

The connection between current algebra and vector meson dominance is explored with applications to soft-pion scattering, the radiative decays of heavy mesons and parity-nonserving decays of strange particles. (L.B.S.)

Strong (Baryon No. = 0)

Refer also to abstracts 5578 and 5642.

5563 (TID-24135) UNIVERSAL COUPLING OF THE OMEGA MESON AND REGGE RESIDUES. Technical Report 691. Banerjee, M. K.; Levinson, C. A. (Maryland Univ., College Park. Dept. of Physics and Astronomy). June 1967. Contract AT-(40-1)-3491. 16p. Dep. CFSTI.

Some of the experimental data in favor of the experimental hypothesis of universality of omega coupling is considered. The low energy data on the coupling of omega meson and the high-energy data on the coupling of omega-type Regge trajectory were considered. The data seem to support the universality hypothesis. The universal omega coupling constant $g_{\omega}^2/4\pi$ is estimated to be 1.24 ± 0.31, which is higher than the universal rho coupling constant $g_{\rho}^2/4\pi = 0.65 \pm 0.17$. To relate the Regge residues of vector trajectories to the universal coupling constant the angular momentum dependence of the former is factored out, and "reduced" Regge residue and a scale parameter for each trajectory are introduced. The scale parameters for the omega and the rho trajectories turn out to be remarkably close to one another and are of the order of 260 and 290 MeV, respectively. (auth)

5564 ANALYSIS OF THE S-WAVE ππ INTERACTION FROM THE REACTION $\pi^- p \rightarrow \pi^- \pi^+ n$. Clegg, A. B. (Univ. of Lancaster, Eng.). Phys. Rev., 163: 1664-7(Nov. 25, 1967).

Some recent analyses which deduce s-wave ππ scattering amplitudes from observed peripheral production of s-wave dipions in $\pi^- p$ reactions are discussed; they assume that the ratio of s-wave production to s-wave scattering equals the ratio of p-wave production to p-wave scattering, and take p-wave scattering to be given by the Breit–Wigner amplitude describing the ρ meson. As a procedure involving fewer assumptions, it is suggested that one might only assume the phases of these two ratios to be the same, without making assumptions about their relative magnitudes. Applying this procedure to the compilation of experimental data made by Walker et al. provides a strong indication that the I = 0 s-wave phase shift is ≈75–80° at a mass of 750 MeV, and indicates that there is some uncertainty in the relative magnitudes of the two ratios mentioned above. (auth)

5565 RADIATIVE DECAYS OF K* MESONS. Sapir, Michael; Singer, Paul (Israel Inst. of Tech., Haifa). Phys. Rev., 163: 1756-63(Nov. 25, 1967).

A general analysis of the first-order radiative decays of K* mesons, namely, $K^* \rightarrow K\gamma$, $K^* \rightarrow K\pi\gamma$, and $K^* \rightarrow K\pi\pi\gamma$, is presented. The main emphasis is on the decay processes $K^{*+} \rightarrow K^+\pi^0\gamma$, $K^{*+} \rightarrow K^0\pi^+\gamma$, $K^{*0} \rightarrow K^+\pi^-\gamma$, and $K^{*0} \rightarrow K^0\pi^0\gamma$, which reveal the electromagnetic structure of K* mesons. These decays can proceed through inner bremsstrahlung as well as direct emission, and they turn out to be the principal K* radiative processes. The inner-bremsstrahlung contribution results in a decay probability of approximately 1% of the strong decay for γ rays with energies exceeding 10 MeV. The variation of the probability with the value of the K* magnetic moment is calculated. The direct decays are shown to be generally several orders of magnitude weaker. The decay $K^{*0} \rightarrow K^0\pi^0\gamma$ is the only channel in which the two mechanisms are comparable. (auth)

5566 IMPLICATIONS OF UNEQUAL-MASS KINEMATICS FOR THE REGGE-POLE MODEL OF VECTOR-MESON PRODUCTION. Jones, Lorella (California Inst. of Tech., Pasadena). Phys. Rev., 163: 1523-9(Nov. 25, 1967). (CALT-68-126).

Application of the Regge-pole model to vector-meson production by incident pseudoscalars is re-examined in the light of recent theoretical advances in the treatment of unequal-mass processes. It is found that in the absence of conspiracy between trajectories at t = 0, the kinematic factors separated from the helicity amplitudes before Reggeization tend to suppress the effects of parity = $(-1)^J$ exchanges relative to parity = $(-1)^{J+1}$ contributions, in the region $|t| \leq 0.2$ GeV^2. This helps account for the experimental observation that, although α_π is less than α_{A2}, α_ω, ..., π exchange tends to dominate the forward peak wherever it is possible (production of ρ and K* mesons). This kinematic suppression also helps explain the failure of ρ exchange to dominate in ω production. (auth)

5567 EXAMPLE OF A REGGE DAUGHTER TRAJECTORY FOR I = 1, Y = 0 BOSON RESONANCES. Spector, R. M. (Wayne State Univ., Detroit). Phys. Lett., 25B: 551-3(Nov. 13, 1967).

A number of known I = 1, Y = 0 boson resonances are assigned to two Regge trajectories by combining the information from both a Chew-Frautschi plot and an imaginary spin versus real spin (Regge trajectory) plot. One trajectory is conjectured to be the daughter of the other and several predictions are made about the quantum numbers of known resonances. In addition, the masses and widths of some new resonances are predicted. (auth)

5568 DYNAMIC REFERENCE SYSTEM FOR SPIN QUANTIZATION. Donohue, J. T.; Hoegaasen, H. (CERN, Geneva). Phys. Lett., 25B: 554-6(Nov. 13, 1967).

Among the many reference systems one can use in describing the spin structure of vector particles a unique one is considered—the one where the "observable" part of the density matrix is diagonal and therefore has elements that are invariants. This reference system is called the dynamical one and some simple aspects of it in the absorption model and how it can be determined directly from experiment are pointed out. (auth)

5569 SPECTRAL-FUNCTION SUM RULES, $\omega-\varphi$ MIXING, AND LEPTON-PAIR DECAYS OF VECTOR MESONS. Oakes, R. J. (Brookhaven National Lab., Upton, N. Y.); Sakurai, J. J. Phys. Rev. Lett., 19: 1266-70(Nov. 20, 1967). (COO-264-405).

Within the framework of vector-meson dominance, the current-mixing model is shown to be the only theory $\omega-\varphi$ mixing consistent with Weinberg's first sum rule as applied to the vector-current spectral functions. Relations among the leptonic decay rates of ρ^0, ω, and φ are derived, and other related processes are discussed. (auth)

5570 ON π-MESON SPECTRA IN $K \rightarrow 3\pi$, AND $\eta \rightarrow 3\pi$ DECAYS. Anisovich, V. V.; Dakhno, L. G. (Inst. of High Energy Physics, Kazan). Yadern. Fiz., 6: 845-8(Oct. 1967). (In Russian).

The $\pi\pi$-interaction low-energy data available give four possible values for π-meson scattering lengths: $a_0 \approx 0.7$, $a_2 \approx 0.2$; $a_0 \approx 0.9$, $a_2 \approx -0.6$; $a_0 \approx -0.1$, $a_2 \approx -0.9$; $a_0 \approx -0.1$, $a_2 \approx 1.4$ (in the units $\hbar/\mu_\pi c$). Assuming that the behavior of π-meson spectra in $K \rightarrow 3\pi$- and $\eta \rightarrow 3\pi$-decays is fully due to the interaction of the π-mesons produced at low energies, the experimental data are in the favor of the first solution $a_0 \approx -0.7$, $a_2 \approx 0.2$. (auth)

5571 REPRESENTATION FOR PARTIAL AMPLITUDES AND SOLUTION OF THE NEUTRAL MODEL OF THE $\pi\pi$ SCATTERING. Orlov, I. I.; Parfenov, Yu. V. (Inst. of Mathematics and Computer Center, Novosibirsk, USSR). Yadern. Fiz., 6: 849-52(Oct. 1967). (In Russian).

The problem of the low-energy scattering is formulated in such a way that the knowledge of the spectral representations for the partial amplitudes is not necessary. In case of the neutral-meson scattering the known explicit solution for the s wave is reproduced. (auth)

5572 ON A SOLUTION OF CHEW–LOW TYPE EQUATIONS. Meshcheryakov, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Dokl. Akad. Nauk SSSR, 174: 1054-6(June 11, 1967). (In Russian).

The scattering of pions on a fixed source is described by a Chew–Low type of equation by use of a two-particle approximation under conditions of unitarity. It is convenient to consider first the most general properties of the solutions of this equation. These properties are formed in terms of analytical functions $h_j(z)$ of a complex variable, where the function $h_j(\omega) = \lim h_j(z + i\epsilon)$. The properties of $h_j(z)$ which are investigated are the following: the meromorphicity of $h_j(z)$ in the plane z having cuts of $(-\infty, -1)$ and $(+1, +\infty)$; the reality of $h_j(z)$, the unitarity of $h_j(z)$; and the crossing symmetry of $h_j(-z) = A_{ij}h_j(z)$. Functions satisfying concrete equations of the Chew–Low type can be selected after analyzing the above properties. (TTT)

Strong (Baryon No. = 1)

Refer also to abstract 5548.

5573 (INR-825/VI/PH) AN ATTEMPT TO DETERMINE VAN HOVE'S OVERLAP FUNCTION AND SHADOW ELASTIC SCATTERING FROM THE MEASUREMENTS OF INELASTIC π^+p INTERACTIONS AT 8 GeV/c. Michejda, Lech (Institute of Nuclear Research, Warsaw (Poland)). 1967. 39p. Dep.

From the measurements of π^+p inelastic reactions at 8 GeV/c the Van Hove overlap function is determined assuming no correlations among secondary particles, a constant phase of the wave function and neglecting spins. The overlap functions obtained for various channels are used to compare how much peripheral or central are these collisions. It was found that the computed overall overlap function violated unitarity bounds on partial inelastic cross sections G^l_{in} and is in striking disagreement with the G^l_{in} estimated from the inelastic differential cross section. It seems that the failure of the calculation is mainly due to the incorrect assumption that the phase of the many-body wave function does not depend on the momentum configuration of the final-state particles. (auth)

5574 $\pi + N \rightarrow N^*$ PRODUCTION IN THE QUARK MODEL. Wakaizumi, Seiichi (Kyoto Univ., Japan). Progr. Theor. Phys. (Kyoto), 38: 662-70(Sept. 1967).

The cross section for the $\pi + N \rightarrow N^*$ production is calculated in the quark model using the static approximation for quarks. It is assumed that the incident pion is absorbed by a quark in the nucleon, resulting in the excitation of the nucleon. The main results are that the extension of the nucleon wave function is about $2.0 \sim 3.5$ GeV^{-1} and that the coupling constant of the pion with the quark is $f^2_{qq\pi}/4\pi \approx 0.3$. The ratio of the cross section of the process passing through the resonance N^* to the total cross section is also roughly given. The selection rule for the orbital angular momentum of the incident pion is obtained and agrees well with the experiment. (auth)

5575 QUARK MODEL AND TWO-BODY REACTIONS. II. Kawaguchi, Masaaki; Yokomi, Hiroyuki (Osaka Univ., Toyonaka, Japan). Progr. Theor. Phys. (Kyoto), 38: 735-7(Sept. 1967).

A quark model with an additivity assumption, which was applied to elastic scattering and various reactions, is extended to the backward processes. By backward processes is meant that the baryon in the final state goes out at 180° with respect to the initial baryon. The $\pi^+ + p \rightarrow \Sigma^+ + K^+$ process is discussed. (J.F.P.)

5576 A NOTE ON SUPERCONVERGENCE RELATIONS IN THE PRESENCE OF REGGE CUTS. Igi, Keiji (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 38: 741-3(Sept. 1967).

It is pointed out that from a practical point of view it is not crucial whether $\alpha_\rho(0)$, where α_ρ is the ρ Regge trajectory, should be above or below $\frac{1}{2}$. It is assumed that the Regge cut asymptotic behavior is already established at high energies. The helicity-flip forward scattering amplitude is considered for a particular pseudoscalar meson–baryon scattering where only the I = 2 trajectory exchange (with the same quantum numbers of I = 2 mesons) is possible. (J.F.P.)

5577 PARTIAL MUON CAPTURE IN LIGHT NUCLEI. Fujii, A. (Sophia Univ., Tokyo). pp 39-62 of Symposia on Theoretical Physics. Vol. 3. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

Theoretical and experimental data are reviewed in order to determine whether the universal V–A law holds in the meson (μ) capture reaction. The topics covered are the atomic capture rate in hydrogen, molecular processes and molecular capture rate in liquid hydrogen, the capture rate in nuclei, and the experimental partial capture rate. (J.F.P.)

5578 DETERMINATION OF THE S-WAVE $\pi\pi$ PHASE SHIFTS IN THE ρ REGION FROM 4.16-GeV/c π^-p INTERACTIONS. Johnson, P. B.; Gutay, L. J.; Eisner, R. L.; Klein, P. R.; Peters, R. E.; Sahni, R. J.; Yen, W. L.; Tautfest, G. W. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 163: 1497-1501(Nov. 25, 1967).

The results of a calculation of the T = 0 and T = 2 S-wave $\pi\pi$ elastic scattering phase shifts in the ρ region are presented. Two solutions are found for both. One set for δ^0_0 does not pass through 90°. The physically acceptable solution for the δ^2_0 phase shift is found to be small ($|\delta^2_0| < 20°$). The absorption corrections are essential for the determination of δ^0_0. (auth)

5579 FERMION REGGE TRAJECTORY IN FIELD THEORY. Berger, Edmond L. (Dartmouth College, Hanover, N. H.). Phys. Rev., 163: 1614-18(Nov. 25, 1967).

In a conserved-vector-current theory of a spin-$\frac{1}{2}$ fermion interacting with a vector meson of finite mass, the fermion Regge trajectory, $\alpha(s) = J - \frac{1}{2}$, is derived from the dominant and second-most-dominant large-momentum-transfer terms through fourth order in the complete Feynman–diagram expansion of the helicity amplitudes. For energy s approaching threshold from below, a(s) is real and proportional to $1/\ln(-k^2)$, where k is the momentum in the center-of-mass system; eliminated, therefore, is the familiar divergence at threshold obtained when only the dominant terms are retained. The threshold limiting behavior is discussed. (auth)

5580 HIGH-SPIN BARYONS. V. DYNAMICAL MODEL FOR REGGE RECURRENCES OF INELASTIC RESONANCES: NUMERICAL RESULTS. Carruthers, P. (Cornell Univ., Ithaca, N. Y.); Nieto, Michael Martin Phys. Rev., 163: 1646-63(Nov. 25, 1967).

Virtual transitions of the type $\pi N_i \rightarrow \rho N_j$, where N_i and N_j are arbitrary nucleon isobars, are considered as possible mechanisms for Regge recurrences. It is found that the largest one-pion-exchange forces coupling to $(\rho N_1)_{L=0}$, $(\rho N_2)_{L=0}$, ... [where N_1, N_2, ...

have spin-parity J^P of S^P, $(S+2)_?$, ...] occur in the opposite-parity states $(S+1)^{-P}$, $(S+3)^{-P}$, ... The most important couplings seem to be "diagonal," i.e., $N_i = N_j$. In this case, isospin $\frac{1}{2}$ always dominates. If all $\pi N_i N_i$ couplings are of the same order of magnitude, then there are negative-parity trajectories that follow along with the positive-parity trajectories. It is found that the one-pion-exchange amplitudes lead to substantial violations of unitarity and to spectrum inversion for "off-diagonal" couplings ($N_i \neq N_j$) involving large momentum transfers. To deal with this problem a one-parameter "form factor" is introduced. Because of the uncertainties of coupling constants and form factor, predictions of resonance energies and branching ratios are somewhat adjustable. However, resonances occur in states having the correct quantum numbers, and the calculated widths are surprisingly good. The given nucleon (N_1^+) and Δ_1^+ trajectories leads to the N_1^- trajectory with $(T,J^P) = (\frac{1}{2}, \frac{3}{2}^-)$, $(\frac{1}{2}, \frac{7}{2}^-)$, ... and the N_1'-trajectory $(\frac{1}{2}, \frac{5}{2}^-)$, $(\frac{1}{2}, \frac{9}{2}^-)$, ... In addition there is possibly another $(\frac{1}{2}, \frac{1}{2}^-)$, $(\frac{1}{2}, \frac{5}{2}^-)$, ... sequence at rather high mass. The "exothermic" reactions for which $M(N_i) > M(N_j)$ lead to possible isospin-$\frac{3}{2}$ resonances $(\frac{3}{2}, \frac{1}{2}^-)$, $(\frac{3}{2}, \frac{5}{2}^-)$, ..., but these calculations are not considered very reliable. The virtual-f configurations fN_j are also considered. These characteristically involve considerably larger momentum transfers than do the corresponding ρ-meson configurations. If the fN_j amplitudes are modified by the same function used to repair the ρN_j couplings, no resonances result from the fN_j mechanism. However, present methods of computing the magnitude of this high-momentum-transfer effect are unreliable. Extension of the vector-meson model to SU(3) leads to 8 and 1 trajectories with $\frac{3}{2}^-$, $\frac{7}{2}^-$, ... and 8 alone for $\frac{5}{2}^-$, $\frac{9}{2}^-$, ... and the doubtful companion $\frac{1}{2}^-$, $\frac{7}{2}^-$, ... and 8 alone for $\frac{5}{2}^-$, $\frac{9}{2}^-$, ... and the tion mechanism to a tensor nonet T_8 leads to hitherto unobserved representations. $P_8 + B_8 \rightarrow T_8 + B_8$ would give 8, 10^*, and 1 representations with spin J^P of $\frac{5}{2}^+$, $\frac{9}{2}^+$, ..., and possibly $\frac{1}{2}^-$, $11/2^-$, ..., while $P_8 + B_{10} \rightarrow T_8 + B_{10}$ would give 10 and 27 representations with $\frac{1}{2}^+$, $11/2^+$: ... if we have underestimated the importance of this effect. Hence present experimental evidence seems to support the conclusions about the relative importance of the vector- and tensor-meson production. The resulting baryon mass spectrum includes most of the prominent observed states. No wrong states are predicted. Some new resonances in the 2-BeV region are suggested. (auth)

5581 NONINVARIANCE GROUPS AND LOW-ENERGY MESON-BARYON SCATTERING. Deshpande, N. G. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 163: 1629-32 (Nov. 25, 1967).

It is shown that consideration of noninvariance groups as well as the Cook–Goebel–Sakita strong-coupling solution may be used to derive low-energy sum rules for p-wave meson-baryon scattering. In particular two sum rules are obtained for pion-nucleon scattering which are in fair agreement with experiment. These are $p^{1,1} = 4p^{1,3} = 4p^{3,1}$. The method is generalized to SU(3) to obtain twelve sum rules for the fourteen p-wave amplitudes. Throughout, a rather simple method of using crossing matrices of the groups $SU(2)_I \times SU(2)_J$ and $SU(3) \times SU(2)_J$ is employed. Several new results are obtained which were not obtained in the previous treatments. (auth)

5582 SOME CONSEQUENCES FROM SUPERCONVERGENCE FOR πN SCATTERING. Igi, Keiji; Matsuda, Satoshi (Univ. of Tokyo). Phys. Rev., 163: 1622-6(Nov. 25, 1967).

Sum rules of the superconvergent type are obtained for the πN helicity-flip and helicity-nonflip amplitudes. The sum rules for the helicity-nonflip amplitudes are shown to be consistent with the Regge-pole-dominance model. Investigation of the sum rule for $B^{(-)}(\nu)$ leads us to speculate as to the existence of resonances on N_β, Δ_γ, and N_δ baryon trajectories. (auth)

5583 CURRENT ALGEBRA, s-WAVE MESON-BARYON SCATTERING LENGTHS, AND THE ADEMOLLO–GATTO THEOREM. Datta, K.; Dhar, J.; Majumdar, Rabi; Gupta, K. C. (Univ. of Delhi). Phys. Rev., 163: 1764-6(Nov. 25, 1967).

s-wave meson-baryon scattering lengths to first order in symmetry breaking are investigated within the framework of the $SU(3) \times SU(3)$ chiral algebra. It is found that there are no renormalization effects in these scattering lengths to first order in symmetry breaking under the assumption of current commutation relations, the hypothesis of partially conserved axial-vector current, and the Ademollo–Gatto theorem for the vector-baryon coupling. However, it the Ademollo–Gatto theorem is not assumed, symmetry-breaking effects are observed in the scattering-length sum rules. (auth)

5584 PHENOMENOLOGICAL MODEL OF DIFFRACTION AND RESONANT SCATTERING. Lasinski, T.; Setti, R. Levi (Univ. of Chicago, Ill.); Predazzi, E. Phys. Rev., 163: 1792-1802(Nov. 25, 1967).

Diffraction phenomena are shown to play an important role in $K^-p \rightarrow K^-p$ elastic scattering, even in the region of ~1 GeV/c, where resonant effects are dominant. A brief review of existing data indicates that the differential cross sections consistently exhibit an exponential behavior at small momentum transfers from ~16 down to ~0.8 GeV/c, and that the scattering amplitudes throughout this region are predominantly imaginary. The slope of the diffractionlike peak is shown to increase sharply at incident K^- momenta, corresponding to the formation of known, higly elastic resonances. A model is then formulated to apply to (π,K)-nucleon two-body processes, in which the scattering amplitudes for each isospin state are described by a linear superposition of diffractive and resonant contributions. On a purely empirical basis, the diffractive amplitudes have been parametrized in terms of an exponential t dependence. The model has been specialized to interpret $K^-p \rightarrow K^-p$ elastic-scattering data from 0.8 to 1.2 GeV/c, where two dominant resonant states are known, the $Y_1^*(1760)$ and $Y_0(1820)$. A good fit to the data yields a reliable set of six resonant parameters (masses, widths, and elasticities) for these states, and three parameters describing the diffractive contribution (real and imaginary part of the forward-scattering amplitude, and slope of the diffraction peak). (auth)

5585 EMPIRICAL MASS FORMULA FOR BARYONS. French, John D.; Lamb, William H. Jr.; Mowat, John G. (Auburn Univ., Ala.). Phys. Rev., 163: 1754-6(Nov. 25, 1967).

An empirical mass formula for baryons is described. When the baryons are grouped according to the particles into which they decay, nearly all the particles fall into a few families. Within each family the masses are closely given by the formula $M = \Sigma_i M_i + M_0[n(n+1)]$, where $\Sigma_i M_i$ is the sum of the decay particle masses, M_0 is a constant for each family, and n is an integer. The relationship of this formula to the mass formula of the SU(3) symmetry theory is discussed. A rigid-rotator model is proposed. A similar relationship for some boson resonances is discussed. (auth)

5586 COUPLINGS OF BARYON RESONANCES FROM CURRENT DIVERGENCES. Graham, R. H.; Pakvasa, S.; Raman, K. (Syracuse Univ., N. Y.). Phys. Rev., 163: 1774-85(Nov. 25, 1967). (NYO–3399-101).

Using the partially conserved axial-vector current hypothesis and assuming the axial-vector current to remain an octet to a good approximation in broken SU_3, relations are obtained for the couplings of baryon resonances with the normal baryons and pseudoscalar mesons. Using a few observed decay widths as input, the strengths of the remaining couplings are estimated. The results are compared with the results of other authors using different approaches and with the sum rules following from a first-order symmetry breaking. (auth)

5587 $\pi^- + p \rightarrow \eta + n$ REACTION NEAR THRESHOLD AND RESONANT STATES OF THE $\pi^- + p$ SYSTEM. Moss, T. A. (Louisiana State Univ., Baton Rouge). Phys. Rev., 163: 1785-7(Nov. 25, 1967).

The differential cross sections for the reaction $\pi^- + p \rightarrow \eta + n$ in the $T_\pi = 593$ MeV to $T_\pi = 704$ MeV energy range are calculated using field-theoretic techniques, and taking into account three resonant states of the $\pi^- + p$ system. Interference effects among these resonances are found to be of importance, and that locating the resonances at 1430, 1512, and 1567 MeV gives the best fit to the experimental data. (auth)

5588 HIGHER SYMMETRIES FOR VECTOR–MESON–BARYON COUPLINGS FROM SUPERCONVERGENCE RELATIONS. Venturi, Giovanni (Univ. of Chicago, Ill.). Phys. Rev., 163: 1826-35(Nov. 25, 1967). (COO–264-386).

Superconvergence relations for vector-meson–baryon scattering are saturated with the baryon octet (B) and decuplet (B*). The sum rules are selected by the infinite-momentum limit and evaluated at zero momentum transfer. Using SU(3) invariance at the vertices and retaining terms to all orders in μ^2/M^2 (μ is the vector-meson mass and M is the baryon mass), a nontrivial solution is obtained for all vector-meson–baryon couplings. For degenerate octet and decuplet masses, this solution is consistent with collinear U(6) symmetry for the vertices and agrees with the corresponding result previously obtained by Oehme on neglecting corrections of order μ^2/M^2 at the 8–10 and 10–10 vertices. It the octet and decuplet mass splittings are retained in a subset of our relations, the deviations from collinear U(6) invariance at the vertices are obtained. Consideration of the ρB scattering processes using only isospin invariance at the vertices and ρ dominance of the isovector form factors leads to broken collinear U(6) relations between the magnetic moments of the baryons. The question of higher intermediate states in the saturation is discussed briefly. (auth)

5589 INFORMATION ABOUT REGGE-POLE COUPLINGS FROM VECTOR-MESON PRODUCTION. Jones, Lorella (Cal-

ifornia Inst. of Tech., Pasadena). Phys. Rev., 163: 1530-5 (Nov. 25, 1967). (CALT-68-125).

Experimental density matrices of the vector mesons and isobars produced in reactions of the form $\pi B \rightarrow VB$ and $\pi B \rightarrow V\Delta$ are compared with predictions obtained by assuming particular couplings at the Regge-baryon-baryon vertex. Couplings are classified according to the total angular momentum J (orbital combined with intrinsic) of the Regge trajectory relative to the incident nucleon in the direct channel. For the $\pi B \rightarrow V\Delta$ case, it is found that the present Regge-pole treatment of unequal-mass kinematics allows one to distinguish between couplings for different J, and that all data are consistent with J = 1. Data for $\pi B \rightarrow VB$ charge-exchange reactions are also consistent with J = 1 dominance. (auth)

5590 ABSORPTION-MODEL ANALYSIS OF $KN \rightarrow K^*(890)N$ REACTIONS. Donohue, John T. (Univ. of Illinois, Urbana). Phys. Rev., 163: 1549-58(Nov. 25, 1967).

The absorptive peripheral model using a mixture of pion and vector-meson exchange is used to analyze data on $K^+p \rightarrow K^{*+}(890)p$ at momenta ≈ 3 GeV/c. The vector-meson exchange couplings are obtained phenomenologically by fitting the experimental data. Good fits are obtained; in particular, evidence is found for an interference effect between pion and vector-meson exchange which causes differences between K^{*+} and K^{*-} reactions. The production of neutral K^* is discussed, and an attempt is made to separate the I = 0 and I = 1 vector-meson exchanges. Some predictions of the model for higher energies are presented, which suggest that the known energy-dependence difficulties of vector-meson exchange will make our method inapplicable. Evidence for the interference effect in other reactions is suggested, and experimental tests are proposed. (auth)

5591 BACKWARD K^+-p ELASTIC SCATTERING AT 1 TO 3.5 GeV/c AND SPIN-PARITY OF $Z_1(1910)$. Minami, S. (Osaka City Univ.). Phys. Lett., 25B: 557-9(Nov. 13, 1967).

A method is proposed to determine the spin-parity of a resonance $Z_1(1910)$, on the basis of the theoretical results that the differential cross section and polarization in backward K^+-p elastic scattering depend strongly on the properties of the $Z_1(1910)$. (auth)

5592 CONSISTENCY OF CURRENT ALGEBRAS. Low, F. E. (Massachusetts Inst. of Tech., Cambridge). pp 75-80 of Proceedings of the Fifth Annual Eastern Theoretical Physics Conference, Brown University, Providence, November 25-26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-661129.

The general question of the consistency of current commutators based on the canonical commutation relations of the underlying fields is discussed. A model of mesons interacting with baryons is briefly described, in which both the Jacobi identity and the canonical commutation rules for covariant densities fail with noted exceptions. (L.B.S.)

5593 METHOD TO IDENTIFY RESONANCES. Kopylov, G. I.; Khvastunov, M. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 780-5(Oct. 1967). (In Russian).

Resonances were identified generally from the effective mass of their decay products. The proposal is to identify the X resonance in the reaction $\pi^- + p \rightarrow n + X$, $X \rightarrow \gamma + \gamma$, from the Lorentz factor. It is shown that under some conditions the resolution using the Lorentz factor is two or three times better than the resolution using the effective mass. (auth)

5594 PION CONSPIRACY IN $\pi N \rightarrow \rho\Delta$. Le Ballac, M. (Argonne National Lab., Ill.). Phys. Lett., 25B: 524-5(Oct. 30, 1967).

The consequences of a conspiratorial choice for the meson (π) are examined assuming that cuts are negligible. It is pointed out that the reactions $\pi + N \rightarrow \rho + \Delta$, $K + N \rightarrow K^* + \Delta$, and $\pi + N \rightarrow f^0 + \Delta$ should exhibit a dip in the forward direction, and that the final formulation of the Frautschi and Jones model, suggested by their phenomenological fits, is indeed the one which would be inferred from a conspiring meson (π). (J.F.P.)

5595 IS SATURATION A GOOD APPROXIMATION TO SUM RULES? Diu, B. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Lett., 25B: 530-2(Oct. 30, 1967).

It is shown that superconvergence plus saturation and bootstrap give similar results in the πN static model. It is also shown that bootstrap amplitudes are not automatically superconvergent. (J.F.P.)

5596 FOUR-MOMENTUM TRANSFER DISTRIBUTION IN HIGH ENERGY, HIGH MULTIPLICITY REACTIONS. Bialkowski, G. (Univ., Warsaw); Sosnowski, R. Phys. Lett., 25B: 519-21(Oct. 30, 1967).

The distribution of the four-momentum transfer to the secondary nucleon in high-energy high-multiplicity π-p interactions is discussed after corrections for the phase space were correctly introduced. It is shown that the distribution is of the same general shape as that for the two body interactions. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 4470.

5597 (INR-813/VI/PH) ANALIZ FOTOMEUL'SIONNYKH DANNYKH O YADERNYKH VEAIMODEISTVIYAKH S ENERGIYAMI $\geq 10^{12}$ eV. (An Analysis of Nuclear Interactions of Energies $\geq 10^{12}$ eV). Mensovich, M.; Gerulya, E. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 25p. (In Russian). Dep.

Results of an analysis of interactions between nucleons of energies higher than 10^{12} eV and emulsion nuclei in two large emulsion stacks are presented. The main results of the emulsion work are presented from the point of view of the fireball model taking into account the possibility of the excitation of the nucleons. (auth)

5598 (JINR-P1-3525) NOVYE REZULTATY FAZOVOGO ANALIZA NUKLON-NUKLONNOGO RASSEYANIYA PRI ENERGII 630 MeV. (New Results of the Phase-Shift Analysis of the Nucleon-Nucleon Scattering at 630 MeV). Glonti, L. M.; Kazarinov, Yu. M.; Rozanova, A. M.; Silin, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 32p. (In Russian). Dep.

The phase-shift analysis of data on the nucleon-nucleon scattering at the energies near to 630 MeV was performed. It is shown that under the assumption of the validity of one-meson approximation, beginning from the orbital moments l = 6, the number of solutions with $\chi^2 \leq 1.5\ \overline{\chi}^2$ is equal to 5. Using a stronger criterion than the χ^2-one, one can show that the maximum probability of a first type error rejecting certain solutions is 5.10^{-4}, 5.10^{-4}, and 4%, respectively. A new set appears which differs essentially from the previously known set. An additional set appears when taking into account the meson production from the nonresonance state $^3F_4$. (auth)

5599 (JINR-P2-3546) RASSEYANIE π-MEZONOV NA VYSTROENNOM DEITRONE I STRUKTURA DEITRONA. (Pion Scattering on the Aligned Deuteron. Deuteron Structure). Tseren, Ch. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 8p. (In Russian). Dep.

The consideration of the multiple scattering of particles on the nucleons in a nucleus leads to two effects: first, the spin-independent part of the cross section is changed; second, the dependence of the total cross section upon the aligned deuteron appears. Thus the total π-d cross section can be written from the performance of the standard transformations. For the first time the value $\delta\sigma$ in the diffraction approximation was estimated by Glauber (The Glauber effect). In this approximation the value σ_1 was calculated. The deuteron wave function at small distances was chosen. Then using certain relations, the expression for σ_1 was obtained. (auth)

5600 DOUBLE HYPER-NUCLEI AND $\Lambda-\Lambda$ INTERACTION. Potashev, A. G. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 8, 35-9(1967). (In Russian).

The binding energy on the double hypernucleus $\Lambda\Lambda^{10}B$ was analyzed on the basis of the α-particle model. The dependence between the binding energy of two Λ-particles $B_{\Lambda\Lambda}$ and $\overline{V}_{\Lambda\Lambda}$ with the volume potential of the $\Lambda\Lambda$ potential was found. For the experimental value $B_{\Lambda\Lambda} = 17.5$ MeV $\overline{V}_{\Lambda\Lambda}$ changes in the limits from 250 to 850 MeV $\cdot\ \phi^3$ with use of the different existing forms of the $\alpha-\alpha$ potential. (tr-auth)

5601 ON BREAK-UP CHANNELS IN MUON CAPTURE BY ^{3}He. Pascual, R. (International Centre for Theoretical Physics, Trieste, Italy). Nucl. Phys., B3: 561-4(1967). (IC-67/54).

A calculation of the capture rate of μ^- by ^{3}He in the channel $n + n + p + \nu$ is presented. The result is lower than some previous estimations, but it is in agreement with the experimental data. (auth)

5602 THE $_{\Lambda\Lambda}{}^{11}$Be INTERPRETATION OF THE FIRST DISCOVERED $\Lambda\Lambda$ HYPERNUCLEAR EVENT. Ali, S.; Kok, L. P. (International Centre for Theoretical Physics, Trieste, Italy). Nucl. Phys., B3: 547-52(1967).

The $_{\Lambda\Lambda}{}^{11}$Be interpretation of the $\Lambda\Lambda$ hypernuclear event reported by Danysz et al. (the usual interpretation adopted so far being that the event was most probably an example of $_{\Lambda\Lambda}{}^{10}$Be) was investigated by assuming a $\Lambda\Lambda$ core model (with due allowance for core distortion by the Λ-particles), using $\Lambda\Lambda$ potential strengths which are well determined from $_{\Lambda\Lambda}{}^{6}$He. It is shown

that for reasonable values of the nuclear compressibility coefficient, the results for both the two-pion and the K-meson ranges for the Λ-N interaction are fairly compatible with experimental results. (auth)

5603 REGGE-POLE ANALYSIS OF pn → np AND $p\bar{p} \rightarrow n\bar{n}$ SCATTERING. Arbab, Farzam; Dash, Jan W. (Univ. of California, Berkeley). Phys. Rev., 163: 1603-10(Nov. 25, 1967).

The differential cross sections for the reactions pn → np and $p\bar{p} \rightarrow n\bar{n}$ were investigated. It is found that besides the p and R(A_2) trajectories, the π and B trajectories must be included. A variety of schemes suggested by four-dimensional symmetry were investigated. The existence of various daughter trajectories does not suffice to explain the data, though the data can be fitted with a parity doublet, of which the pion may or may not be a member. In the former case some structure must be introduced into the pion residue function. (auth)

5604 LOW-ENERGY NUCLEON–NUCLEON SCATTERING IN A THREE-BODY FORMALISM. Varma, V. S. (Univ. of Delhi). Phys. Rev., 163: 1682-7(Nov. 25, 1967).

The NNπ system is studied using the Faddeev theory of three-particle interactions and the approximation scheme due to Lovelace, which preserves bound-state and three-particle unitarity and uses separable potentials to describe off-shell two-particle scattering amplitudes. One-dimensional coupled integral equations are obtained for elastic nucleon-nucleon scattering which decouple in the I = 0, S = 0 state. The theory, which contains no arbitrary parameters, predicts phase shifts which are in reasonable agreement with experiment for the higher partial waves. (auth)

5605 LOW-ENERGY ΞN AND ΛΣ INTERACTIONS. Pappademos, John N. (Univ. of Illinois, Chicago). Phys. Rev., 163: 1788-91(Nov. 25, 1967).

The low-energy ΞN and ΛΣ interactions were studied by the method of solving the coupled-channel Schrödinger equation. Using meson-exchange potentials to represent the outer regions and a phenomenological hard core to represent the inner regions of the interactions, the zero-energy scattering lengths and phase shifts as a function of energy have been computed for various choices of coupling parameters. No bound states in these systems are indicated for the most likely values of coupling parameters and core radii. (auth)

5606 ABSORPTIVE PERIPHERAL MODEL FOR THREE-BODY FINAL STATES: NN → NNρ. Saperstein, Alvin M. (Wayne State Univ., Detroit); Shrauner, E. Phys. Rev., 163: 1559-68(Nov. 25, 1967).

An absorptive peripheral model for production processes involving three-body final states is developed. Motivated by the success of the absorptive peripheral model for the two-body reactions (πN → ρN), the same Born approximation is incorporated as a subprocess into a double peripheral Born approximation for production of mesonic resonances in nucleon-nucleon collisions (NN → NNρ). Absorptive effects of interactions in the three-body final states are taken into account by the method of the high-energy distorted-wave Born approximation applied successively to two-body subsystems (ρ,N) that are then recoupled: (N(ρ,N)). An approximation scheme for very-low-momentum-transfer events is developed from which curves predicting the characteristic shapes and magnitudes of the differential cross sections are calculated. The general formalism developed is sufficient for more detailed calculations at almost any degree of complexity in case the basic foundations of the model are found to be justified. (auth)

5607 PLANNING OF REGRESSION AND DISCRIMINATING EXPERIMENTS ON THE NN SCATTERING. Pazman, A.; Fedorov, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 853-7(Oct. 1967). (In Russian).

Formulas are deduced that allow one to substitute the continuous regression planning by the successive one (with a finite time). A new method for planning the discriminating experiments is presented and compared with other methods. (auth)

5608 TESTS FOR REGGE CUTS IN N–N SCATTERING. Phillips, R. J. N. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 25B: 517-18(Oct. 30, 1967).

Spin-dependent effects from cuts are considered. Those in forward scattering, suggested recently, are already known to be small. Other effects in nonforward scattering would be interesting to measure. (auth)

Particle Invariance Principles and Symmetries

General

5609 OCTET DOMINANCE IN WEAK, ELECTROMAGNETIC AND STRONG INTERACTIONS. Mueller, V. F.; Stech, B. (Univ., Heidelberg). Nucl. Phys., B3: 464-8(1967).

The current-algebra technique is used to express the S-wave hyperon decay amplitudes and the 2π-decay amplitudes of the K_S^0 by one-particle matrix elements of the nonleptonic parity-conserving weak interaction Hamiltonian. The experimental data show octet dominance. The matrix elements thus obtained enable one to test a hypothesis according to which the dominant parts of the parity-conserving weak, the electromagnetic and the strong interactions should to a good approximation be components of the same octet. Predictions for the ratios of one-particle matrix elements in the three different interactions turn out to be fulfilled in sign and magnitude. The results support the idea of a common dynamical mechanism for octet dominance in all three interactions. (auth)

5610 COMPLETENESS OF IRREGULAR REPRESENTATIONS OF A ROTATION GROUP. Sannikov, S. S. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 12: 1216-18(July 1967). (In Russian).

In a previous publication, the irreducible infinitesimal representation of the R_3 rotation group $D^{\pm}(\lambda)$ which corresponds to any arbitrary complex value λ of the spin was examined. It was attempted to solve a question involving the completeness of the earlier representation, transposing the theorems derived from the theory of regular representations of M. A. Naimark to a class of singular functions, considered immeasurable in the usual sense. The linear $L^{+}(\lambda)$ system may be measured by means of a strongly indefinite scalar derivation determined by a Hermitian integral. The problem is considered on the basis of Riemann surface and Schwartz topology. (TTT)

5611 EQUAL-TIME COMMUTATORS INVOLVING DIVERGENCES OF CURRENTS. Kuo, T. K.; Sugawara, Masao (Purdue Univ., Lafayette, Ind.). Phys. Rev., 163: 1716-20 (Nov. 25, 1967). (COO–1428-31).

A study is made on the equal-time commutators between the time and space components of vector and axial-vector currents and also between the time components and the divergences of these currents. The only assumption made is that these commutators consist of terms proportional to the δ function and at most the first-order space derivatives of the δ function. Lorentz covariance and consistency among the commutators lead to partial determination of the above commutators, including the result that the Schwinger terms are symmetric in the SU(3) indices. The resulting set of commutators is sufficient to demonstrate that the off-mass-shell strong matrix element, in which two of the bosons are made off the mass shell by means of the divergences of the axial-vector currents, maintains manifest symmetry with respect to the boson variables even after partial integrations are done. Conservation of some of the currents leads to further determination of the commutators. Thus, for example, when SU(2) symmetry is exact, all the components and also the divergences of these currents have the same SU(2) transformation properties as the corresponding time components. (auth)

5612 AXIAL-VECTOR CURRENT CONSISTING OF PSEUDOSCALAR OCTET [PART] II. Kuo, T. K.; Sugawara, Masao (Purdue Univ., Lafayette, Ind.). Phys. Rev., 163: 1721-6 (Nov. 25, 1967). (COO–1428-30).

Some critical discussions are presented on the set of vector and axial-vector currents which were constructed previously in terms of the (spinor) baryons and pseudoscalar bosons alone, and whose time components satisfy the SU(3) × SU(3) algebra upon equal-time commutation. The boson parts of the above axial-vector currents contain triple products of pseudoscalar fields and, therefore, contain obvious divergences of the self-energy type. It is shown that these divergences can be made to cancel among themselves so that the octet currents are free from such divergences, if all the pseudoscalar bosons have the same bare mass. It is furthermore shown that, if this condition for the bare mass is satisfied, the leptonic decays of the pion and kaon can be understood simultaneously when the Cabibbo angle satisfies $\tan\theta \lesssim m_\pi/m_k$. Another novel feature of the above currents is that the equal-time commutators between the time components of the axial-vector currents and the space components of all the currents contain, in addition to the Schwinger terms, noncovariant terms which are proportional to the space δ function. These noncovariant terms affect virtually all the applications of current commutators to the electromagnetic and weak matrix elements. In particular, the Kroll-Ruderman limit of pion photoproduction on nucleons is generally violated by such noncovariant terms, implying that the pion fields cannot, in general, be proportional (as operators) to the divergences of the axial-vector currents in a field theory underlying the currents under discussion. However, it is pointed out

that there seems to be a specific dynamical mechanism which suppresses the contribution of the above noncovariant terms to the Kroll-Ruderman limit. Thus, the usefulness of the current-commutator approach in pion photoproduction is not expected to be vitiated by such noncovariant terms. (auth)

5613 DERIVATION OF THE SU(3) X SU(3) SPACE-TIME LOCAL CURRENT COMMUTATORS. Gross, David J.; Jackiw, Roman (Harvard Univ., Cambridge, Mass.). Phys. Rev., 163: 1688-96(Nov. 25, 1967).

The commutators of the charge with the current density of vector and axial-vector currents are derived, and restrictions are placed on the Schwinger terms present in the charge-density–current-density equal-time commutators. In order to prove these results, the commutator of the time component of a current with the energy density is derived. The following assumptions are made: (1) Equal-time commutation relations between time components of vector and axial-vector currents satisfy the local SU(2), SU(2) × SU(2), or SU(3) × SU(3) algebra; (2) the transformation properties of the divergence of the axial current are assumed to be known. The second assumption is shown to be necessary as well as sufficient. It is shown that the Schwinger terms involve at most one derivative of a δ function and have definite symmetry properties. Symmetry properties frequently conjectured for the Schwinger terms are examined in the context of the present investigation, and the consequences of these conjectures are explored. The current-density–current-density equal-time commutation is also studied with the present techniques, and it is found that only very mild restrictions can be imposed in a model-independent fashion. (auth)

5614 NECESSARY AND SUFFICIENT CONDITIONS FOR THE CURRENT-SPECTRAL-FUNCTION SUM RULES. Nieh, H. T. (State Univ. of New York, Stony Brook). Phys. Rev., 163: 1769-71(Nov. 25, 1967).

Necessary and sufficient conditions are given for the validity of the Weinberg-type current-spectral-function sum rules. For one class of the sum rules, the validity rests on the equality of the vacuum expectation values of the corresponding Schwinger terms. For the other class, the condition involves the triple commutator of the space component of the current with the Hamiltonian (of the world). Comments are made on the usual derivation of the sum rules and Lee, Weinberg, and Zumino's algebra of fields. (auth)

5615 POSSIBILITY OF DETECTING A SMALL TIME-REVERSAL-NONINVARIANT TERM IN THE HAMII TONIAN OF A COMPLEX SYSTEM BY MEASUREMENTS OF ENERGY-LEVEL SPACINGS. Favro, L. D.; McDonald, J. F. (Wayne State Univ., Detroit). Phys. Rev. Lett., 19: 1254-6(Nov. 20, 1967).

A study was made of how a small time-reversal-noninvariant term in the Hamiltonian of a complex system affects the theoretical statistical distributions of its energy levels. It is found that the major effect on the nearest-neighbor spacing distribution is in its shape near the origin. Thus, it is concluded that experimental observation of such a term by measurement of statistical distributions of energy levels is very difficult. However, one can find an upper bound to the strength of such a perturbation by such measurements. (auth)

5616 APPLICATIONS OF CURRENT ALGEBRA. Lee, Benjamin W. (State Univ. of New York, Stony Brook). pp 65-74 of Proceedings of the Fifth Annual Eastern Theoretical Physics Conference, Brown University, Providence, November 25–26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-661129.

The applications of current algebra to low-energy theorems, approximate symmetry and classification of the hadron spectrum, and local commutation relations are discussed. (L.B.S.)

5617 PARTICLE SYMMETRY. Matthews, P. T. (Imperial Coll. of Science and Tech., London). Endeavour, 26: 63-7(May 1967).

Experiments in high-energy physics have produced, in recent years, so many new particles that they cannot all be considered as elementary particles in the classical sense. In addition, the fact that energy and mass are interconvertible means that it is not necessary for these new particles to have been present in those that originally collided. It has been found, however, that these particles can be arranged in symmetrical groups if they are thought of as being composed of hypothetical subnuclear entities referred to as 'quarks.' The logic of this symmetrical arrangement is explained, and some of the unusual properties of the hypothetical quarks are described. (auth)

5618 POSSIBLE TEST OF A CURRENT ALGEBRA SUM RULE IN NUCLEAR PHYSICS. Scheck, F.; Schuelke, L. (Univ., Heidelberg). Phys. Lett., 25B: 526-9(Oct. 30, 1967).

A generalization of the Cabibbo–Radicati sum rule for light nuclei of arbitrary spin is discussed. It is shown that under reasonable conditions the difficulties connected with the determination of the isovector photo-absorption cross sections can be avoided, thus making possible a meaningful test of the sum rule for nuclei. In the case of the pair $^3He-^3H$ the sum rule is compatible with the experimental data. (auth)

Applications (Electromagnetic and Weak)

5619 (NYO–1932(2)-127) CP NON-INVARIANCE, ELECTROMAGNETIC INTERACTION, AND FIELD-CURRENT IDENTITIES. Lee, T. D. (Columbia Univ., New York). [1967]. 27p. (CONF-670923-3). Dep. CFSTI.

From 3rd International Symposium on Electron and Photon Interactions at High Energies, Stanford, Calif.

The possibility that the CP violation is due to the electromagnetic interaction is considered. The present status of CP noninvariance, implications of nonconservation, theoretical consequences of $C_\pi H_{\gamma\pi} C^{-1} \neq H_\gamma$, and a summary of the experimental consequences are covered. The algebraic relations between K_μ part of the hadronic electromagnetic current, and other observed currents are discussed. These are derived based on the general ideas of field–current identity. (J.F.P.)

5620 SU(3) THEORY OF THE THREE-BODY LEPTONIC DECAYS OF MESONS. van der Merwe, P. du T. (Atomic Energy Board, Pelindaba, S. Africa). Progr. Theor. Phys. (Kyoto), 38: 733-5(Sept. 1967).

The SU(3) theory of the three-body leptonic decays of pseudoscalar mesons is considered. It is found that the hypothesis of an octet vector current and the extended notion of universality provide a unified framework for treating the leptonic decays of pseudoscalar mesons. It is of significance that all the decays yield, to within experimental errors, the same mixing angle. This result suggests that the existence of a weak octet current is known to nature. The theory yields two yet unobserved decay modes which may serve as a test of the theory. (J.F.P.)

5621 BROKEN SYMMETRIES, CURRENT ALGEBRAS, AND WEAK INTERACTIONS. Oehme, Reinhard (Univ. of Chicago). pp 1-37 of Symposia on Theoretical Physics. Vol. 3. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

The semileptonic and leptonic interactions are considered on the basis of current algebras. From the currents involved in lepton–lepton couplings the algebra of U(4) is obtained. Two models for universal weak interactions are found. A brief discussion of the phenomenological situation concerning the leptonic decays of mesons and baryons is presented. (J.F.P.)

5622 SU(3) THEORY OF THE THREE-BODY LEPTONIC DECAYS OF PSEUDOSCALAR MESONS. Van Der Merwe, P. Du T. (Atomic Energy Board, Pelindaba, Africa). Nucl. Phys., B3: 601-8(1967).

An SU(3) theory of the Cabibbo kind is considered for the vector current of pseudoscalar mesons. An appealing feature of the unitary symmetry theory is that it provides a unified framework for treating the decays of particles belonging to an irreducible representation. A formula for the three-body leptonic decay modes is derived in closed form. Comparison of theoretical and experimental rates yields a value $\theta_V^{(M)} = 0.23$ rad within experimental errors for the mixing angle of the vector current. The SU(3) results for the $\Delta S = 0$ decays are compared with the conserved vector isospin current hypothesis. This provides a test for the extended notion of universality. The well-known suppression of the $|\Delta S| = 1$ decays is accommodated by small $\theta_V^{(M)}$. It is of significance that all the $|\Delta S| = 1$ decay rates yield the same value for $\theta_V^{(M)}$ within the experimental accuracy. The theory yields two as yet unobserved decay modes, the rates of which may serve as a test of the theory. (auth)

5623 A PHENOMENONOLOGICAL MODEL OF T VIOLATION IN NONLEPTONIC DECAYS. Kenny, Brian G. (Univ. of Chicago). Contract AT(11-1)-264. Ann. Phys. (N.Y.), 43: 25-71(1967). (COO–264-351).

A phenomenonological model of T violation, which assumes constant T-violating phases in an effective Hamiltonian describing nonleptonic interactions, is applied to all nonleptonic decays of hyperons and kaons in order to place constraints on the phases and to establish some connections between the T-violating characteristics of the various decays. It is found that within the framework of existing data, the model is consistent, but that more diverse and accurate experiments are needed to

determine the phases introduced in the model. In principle, by comparing all nonleptonic decays, the phases can be determined uniquely although they cannot, in general, be obtained by considering any one decay. The performance of certain experiments is suggested. Accurate results from these will enable the phases to be determined if the mechanism of T violation is the same, or closely related, in different decays. These include, among others, the following experiments which could throw light on whether or not T violation takes place via some dominant mechanism. Determination of the asymmetry parameters in the various hyperon decays would enable one to distinguish between T violation in the $|\Delta I| = 1/2$, $3/2$ amplitudes. A measurement of the charge asymmetry in the decay $K_2^0 \to \pi^+\pi^-\pi^0$ is a direct test for T violation in the $|\Delta I| = 3/2$ amplitude. A comparison of either the τ^+ with the τ^- rate or the τ'^+ with the τ'^- rate is a test of T violation in the $|\Delta I| = 5/2$ amplitude, and it is worth noting that, of the two, the $\tau'^{\pm}$ comparison provides a much more sensitive test. (auth)

5624 VIOLATION OF CP INVARIANCE AND NON-LEPTONIC DECAYS. Nishijima, K.; Swank, L. J. (Univ. of Illinois, Urbana). Nucl. Phys., B3: 553-60(1967).

A new model of nonleptonic weak interactions is proposed in order to ascribe both CP-conserving and -violating nonleptonic decays to the same primary interaction. (auth)

5625 ISOSCALAR NUCLEON FORM FACTOR FROM O(4,2) DYNAMICS. Kleinert, Hagen (Univ. of Colorado, Boulder). Phys. Rev., 163: 1807-14(Nov. 25, 1967).

The most general theory of isoscalar form factors with O(4,2) as dynamical group and a purely algebraic current operator was constructed for a fermion representation space. Adjusting one free parameter appropriately, it is obtained for the $J^P = 1/2^+$ ground state $G_M^S(t) = [\mu^S/(1 - t/0.71)^2]$; $G_E^S(t) = [1/2/(1 - t/0.71)^2]\{1 + [t/0.71/(1 - t/0.71)]\}$. μ^S is determined to be $\mu^S = -1/6$. The agreement with experiment is excellent for G_M^S/μ^S, moderate for G_E^S, and bad for μ^S. (auth)

Applications (Strong)

5626 HIGH ENERGY TOTAL CROSS SECTIONS AND 36-PLET 2^+-MESONS. Kitakado, Shinsaku (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 38: 653-61(Sept. 1967).

High-energy total cross sections of nucleons and pseudoscalar mesons are analyzed under the assumption that 2^+-mesons (Reggeons), which are exchanged between hadrons, are described by the 36-dimensional reducible representation of SU(3). The universal coupling properties and the extended nonet coupling ansatz are used to determine the coupling of the relevant interaction. (auth)

5627 REPRESENTATIONS OF THE STRONG COUPLING GROUP. Kummer, W. (Inst. for High Energy Physics, Vienna). Ann. Phys. (N.Y.), 45: 1-24(1967).

The irreducible representations of the strong coupling group are derived not only by group contraction but also by the a priori more reliable method of little groups. In the latter case from the content in the compact subgroup important differences are found for the "degenerate" contracted representations, used so far in the literature. A combination of both methods seems very promising for future work. (auth)

5628 FIELD THEORY OF CHIRAL SYMMETRY. Brown, Lowell S. (Yale Univ., New Haven, Conn. Stanford Univ., Calif.). Phys. Rev., 163: 1802-7(Nov. 25, 1967). (SLAC-PUB-327).

An infinite class of chiral-invariant pion-nucleon Lagrange functions is discussed. Each member of this class is shown to be equivalent, under canonical transformation, to the one in which the commutator of the axial current with the meson field is an isotopic spin scalar. If the chiral symmetry is broken in this special canonical frame in a manner that ensures the partial conservation of the axial current, then the theory is unique. (auth)

5629 OCTET F/D RATIOS AND SPIN-W-SPIN MIXING. Dobson, Peter N. Jr. (Univ. of Hawaii, Honolulu). Phys. Rev., 163: 1619-22(Nov. 25, 1967).

The general problem of calculating the F/D ratios for the baryon + pseudoscalar-meson decays of particles assigned to representations of U(6) ⊗ U(6) and $SU(6)_S$, but decaying according to $SU(6)_W$ is considered. Unique predictions are found only for the spin-$1/2$ member of the 1134 and the spin-$3/2$ member of the 700; the values are $-1/3$ and $2/3$, respectively. "Probable" values for the other cases are defined and calculated. Tables of the spin-W spin mixing coefficients are also provided. (auth)

5630 SYMMETRIC QUARK MODEL OF BARYON RESONANCES. Greenberg, O. W.; Resnikoff, M. (Univ. of Maryland, College Park). Phys. Rev., 163: 1844-51(Nov. 25, 1967).

The symmetric quark model of baryon resonances is applied to the (56.0^+), (70.1^-), and (20.1^+) supermultiplets. Using a systematic SU(6) analysis, octet dominance, and dominance of two-body contributions to the mass operator, the Gürsey-Radicati mass formula for the (56.0^+) is derived without use of perturbation theory. An equal-spacing relation is derived for the SU(6)-symmetric mass contribution for the (56.0^+), (70.1^-), and (20.1^+) in ascending order, with the (20.1^+) lying above 2 BeV. A detailed analysis of the (70.1^-), which yields a quantitative fit for the spin-orbit-split negative-parity resonances, is made, with the result that the magnitude of the octet spin-orbit term is about six times greater than the singlet one. The masses and mixing amplitudes for all the resonances in the (70.1^-) are calculated, and it is pointed out that because of the large mixings for $J^P = 1/2^-$ and $3/2^-$, the Gell-Mann–Okubo mass formula cannot be expected to hold for these resonances, so that there is no sense in trying to group them into octets and decuplets. (auth)

5631 SYMMETRIES IN FIRST-APPROXIMATION S-MATRIX THEORY. II. HIGH-RANK SCATTERING. Neville, Donald E. (Univ. of California, Livermore). Phys. Rev., 163: 1591-1603(Nov. 25, 1967). (UCRL-14771-T(Pt.2)).

A study is presented of scattering invariant under any of the groups G = O(n), $S_p(n)$, or SU(n), $n \gg 1$, the scattered multiplets transforming as products of at most two n-quarks plus n-anti-quarks. The low-energy dynamics is studied in "first approximation," and in addition it is assumed that total cross sections σ_{tot} at high energies are determined by Regge poles and/or cuts, and that the Regge parameters upon which σ_{tot} depends are determined mainly by the low-energy dynamics. It is then shown that as $n \to \infty$, σ_{tot} usually remains positive, as unitarity requires. This conclusion is not obvious; it requires detailed calculation to establish and is the main result of the paper. Unitarity is initially in doubt for these systems because in the limit $n \to \infty$ the crossing matrix elements governing the contributions from the vacuum and other singlet trajectories go to zero; and it is the singlet contributions which keep total cross sections positive for the observed case of small n. It is found that σ_{tot} remains positive only because the low-energy dynamics requires nonsinglet trajectories to be produced in pairs, such that each negative contribution to σ_{tot} from one trajectory is almost exactly canceled by a corresponding positive contribution to σ_{tot} from its twin trajectory. Occasionally this cancellation does not occur: If one of the initial multiplets is a representation of G which is not equivalent to its complex-conjugate representation, then in at least one of the direct channels, even after paired contributions are taken into account, σ_{tot} goes slightly negative, $\sigma_{tot} = O(n^{-1}) < 0$. This number is small enough that if the electromagnetic vertex for G transforms as a singlet rather than as one of the generators of G, then the contribution to σ_{tot} from photon exchange will drive σ_{tot} positive again. It is then assumed that at least one of the initial particles has spin. It is shown that so long as the leading nonsinglet trajectories obey $\epsilon\eta_p = +1$ (ϵ = signature, η_p = intrinsic parity), it is not possible to change the sing of σ_{tot} by flipping the helicity of one of the incoming particles from λ to $-\lambda$. A generalization (to arbitrary spin) of the Wagner–Sharp rules for "line reversal" is also derived: In elastic scattering, if one scattered particle is replaced by its antiparticle, then the contribution to σ_{tot} from a given exchanged multiplet changes by a factor of η_{ch} = charge-conjugation parity of the exchanged multiplet. A fairly complete discussion is given of the dependence of σ_{tot} on the C, P properties of the exchanged multiplets. (auth)

5632 PERIPHERAL HADRON SCATTERING AND $[SU(6)]_W$ SYMMETRY. Gur'ev, V. N. Yadern. Fiz., 6: 858-66(Oct. 1967). (In Russian).

Differential cross sections of hadron scattering are obtained in the pole approximation (meson exchange from the SU(3)-symmetry octets is taken into account) and assuming the $[SU(6)]_W$-symmetry for three-particle vertices. Theoretical estimations are compared with experimental data for the reactions with possible charged meson exchange. (auth)

Field Theories

Quantum Field Theory

5633 (NP-17143) QUANTUM FIELD THEORY. Rodenberg, R.; Cantril, J.; Clark, B. P.; Peery, L.; Tunheim, G.; Yoder, J. (Oklahoma State Univ., Stillwater. Dept. of Physics). May 1967. 240p. Dep.

The discussion of quantum field theory covers the Lagrange

formalism and conservation laws (Noether theorem), field equation of the free fields (noncovariant commutation relation), field equations of an interacting field, the meaning of field quantization, second quantization for the Schroedinger field, equivalence to the many body problem, and construction of the Hilbert space, and the Schrödinger and Heisenberg interactions. Also covered are quantizations of the Klein–Gordon field, (the Δ function), the Dirac field (the S function), and the electromagnetic field (the D function), the S-matrix perturbation theoretical expansion, reduction of the S-matrix, Feynman diagrams, vacuum amplitudes (Furry theorem) and the S-matrix theory representation in the momentum space. (J.F.P.)

5634 QUANTUM GAUGE TRANSFORMATIONS. Lukierski, Jerzy (Univ. of Wroclaw). pp 63-74 of Symposia on Theoretical Physics. Vol. 3. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

The discussion of quantum gage transformations includes transformations in electrodynamics and for non-Abelian gage vector fields. A brief review of gage transformations of the first and second kind is also given. (J.F.P.)

5635 MANY-PARTICLE STRUCTURE OF GREEN'S FUNCTIONS. Symanzik, K. (New York Univ., N. Y.). pp 121-70 of Symposia on Theoretical Physics. Vol. 3. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

Axiomatic field theory approaches are listed, their distinctive features are pointed out, and the relative position of the many-particle structure analysis for Green's functions determined. (J.F.P.)

5636 TWO POSSIBLE TESTS OF QUANTUM ELECTRODYNAMICS. Kessler, Paul (College de France, Paris). Cah. Phys., 21: 125-9(Mar.-Apr. 1967). (In French).

Two experimental tests are suggested in order to check the Dirac current for leptons. One of them is based upon a comparison between electron and muon scattering, the other upon a polarized lepton-polarized nucleon scattering reaction. (auth)

5637 REMARKS ON COHERENT STATES IN QUANTUM FIELD THEORY. Rocca, F.; Sirugue, M. (Faculte des Sciences, Marseille). Nuovo Cim. (10), 52B: 142-8(Nov. 11, 1967).

Coherent states of the photon field are rigorously described within the framework of a space-time formalism. The given form allows a rigorous treatment of gauge invariance. (auth)

5638 CASE AGAINST SPECIAL RELATIVITY. Dingle, H. Nature (London), 216: 119-22(Oct. 14, 1967).

A previous argument against the theory of special relativity is restated. This proof concerns the relative rates of two clocks. A brief summary of the development of this theory is also given. (J.F.P.)

5639 WHY THE SPECIAL THEORY OF RELATIVITY IS CORRECT. McCrea, W. H. Nature (London), 216: 122-4(Oct. 14, 1967).

The theory of special relativity is discussed and explained. In this discussion the correctness of the theory is demonstrated, and an argument against the theory is considered. (J.F.P.)

5640 ASYMPTOTIC CONDITION AND COVARIANT GAUGES IN QUANTUM ELECTRODYNAMICS. Willey, Raymond S. (Univ. of Pittsburgh, Pa.). Ann. Phys. (N.Y.), 45: 167-71(1967).

Manifestly covariant quantum electrodynamics is considered in the framework of Lehmann, Symanzik, and Zimmermann. (auth)

5641 ROLE OF THE PHOTON FIELD COMMUTATOR IN THE QUANTUM THEORY OF INTENSITY CORRELATIONS. Paoli, Thomas L. (Stanford Univ., Calif.). Phys. Rev., 163: 1348-53(Nov. 25, 1967).

Correlations between the outputs of two photodetectors illuminated by arbitrary radiation fields are discussed in terms of quantum field theory. Emphasis is placed on evaluating contributions to the mean correlation which originate in the nonzero commutators of the photon field and are within the frequency response of common detectors. The model for a photodetector, which is applicable to detectors with semiconductors or metals as sensitive elements, is described in terms of the one-electron approximation of the band theory of solids. Time-dependent perturbation theory utilizing methods of scattering theory is used to obtain the lowest-order contribution to the mean detector current and mean cross correlation. In contrast to previous discussions, contributions to the mean correlation which are fourth-order in the field-detector coupling and originate in the quantum nature of the photon field are shown to be exactly zero under reasonable assumptions about the physical properties of the detectors. (auth)

5642 CURRENT-ALGEBRA DETERMINATION OF COUPLING PARAMETERS IN VECTOR-MESON FIELD THEORY. Dooher, J. (Adelphi Univ., Garden City, N. Y.). Phys. Rev., 163: 1852-4(Nov. 25, 1967).

The hypothesis of partially conserved axial-vector current and the current algebra are used to obtain some of the coupling parameters in a vector-meson field theory which assumes that the hadron electromagnetic current is a linear combination of neutral vector-meson fields. By use of the Ward identity, results are presented in a form that includes correction factors which take into account the use of unphysical values of the pion and kaon four-momenta. The results also take into account the most general form of vector mixing. (auth)

5643 FIELD-CURRENT IDENTITIES AND ALGEBRA OF FIELDS. Lee, T. D. (Columbia Univ., New York); Zumino, Bruno Phys. Rev., 163: 1667-81(Nov. 25, 1967).

It is shown that the possible identity between the various hadronic current operators and the corresponding spin-1 meson field operators determines the general structure of the hadronic part of the total Lagrangian. In particular, the identity between the isovector electromagnetic current and the neutral ρ-meson field implies that the ρ dependence of the strong interaction must be the same as that in the Yang-Mills theory, except for the mass term of the ρ meson. The explicit form of the interaction Lagrangian makes possible a general study of the local equal-time commutators of the various hadronic current operators, including the effects of the electromagnetic interaction. Many of these electromagnetic correction terms depend only on the general requirement of gage invariance, and are independent of whether the proposed field-current identities are valid or not. For example, the usual Schwinger term $\lambda(\partial/\partial r_j)\delta^3(r - r')$ in the commutator between the time component of any charged hadronic weak interaction current and the jth space component of its Hermitian conjugate should be replaced by $\lambda[(\partial/\partial r_j) + ieA_j]\delta^3(r - r')$, where A_j is the electromagnetic field operator. The contribution of such a correction term, i.e., $\lambda ieA_j\delta^3(r - r')$, remains present in the integrated form of the commutator. In the usual current algebra, λ is mathematically undefined. If field-current identities hold, then these current commutators are the same as the corresponding algebra of the field operators, and λ becomes a well-defined c number. Some speculative remarks concerning the possible extension of the algebra of fields to the lepton currents are presented. (auth)

5644 VACUUM POLARIZATION IN QUANTUM ELECTRODYNAMICS. Johnson, K. (Massachusetts Inst. of Tech., Cambridge); Willey, R.; Baker, M. Phys. Rev., 163: 1699-1715(Nov. 25, 1967). (RLO–1388-513).

It is shown that if the photon propagator is set equal to $1/k^2$ in the expression for the vacuum polarization, then Z_3^{-1} (where Z_3 is the photon wave-function renormalization constant) diverges like a single power of the logarithm of an ultraviolet cutoff in all orders of perturbation theory. The implication of this result upon the possible finiteness of ordinary quantum electrodynamics is discussed. (auth)

5645 ELECTROMAGNETIC CURRENT IN STRONG-COUPLING THEORY. Bose, S. K.; McGlinn, W. D. (Univ. of Notre Dame, Ind.). Phys. Rev., 163: 1772-3(Nov. 25, 1967). (COO–427-65).

It is shown that the electromagnetic-current operator in the strong-coupling theories is unique. (auth)

5646 INFINITE MULTIPLETS AND CROSSING SYMMETRY. I. THREE-POINT AMPLITUDES. Fronsdal, C.; White, R. (Univ. of California, Los Angeles). Phys. Rev., 163: 1835-43(Nov. 25, 1967).

An investigation is made of what remains of crossing symmetry in theories that are conventional local field theories in all but one respect: that infinite irreducible representations of the homogeneous Lorentz group are used. Only vertex functions are studied here; results for scattering amplitudes will be reported in a sequel. It is found that: (i) Form factors for scattering ($t < 0$) and form factors for annihilation ($t > 4m^2$) are strongly related to each other by the requirement that the interaction Lagrangian density be local, but they are not connected by analytic continuation. (ii) In the case of half-integral-spin fields, the empirical fact that the parities of particles and antiparticles are opposite makes it necessary to use a pair of conjugate irreducible representations, rather than a single unitary irreducible representation. An analog of the Dirac equation allows one to avoid parity doubling and to ensure a proper physical interpretation, provided that quantization is carried out with anticommutators. (auth)

5647 UNIMODULAR MATRICES HOMOMORPHIC TO LORENTZ TRANSFORMATIONS IN $n \geq 2$ SPACELIKE DIMENSIONS. Saenz, A. W. (Naval Research Lab., Washington, D. C.); Wigner, E. P. Z. Naturforsch., 22a: 1293-9(Sept. 1967).

The usual homomorphism between 2 × 2 unimodular matrices B(Λ) and restricted 4 × 4 Lorentz matrices Λ is generalized to the case of one timelike and n ≥ 2 spacelike dimensions. For every such n which is even (odd), this generalization associates homomorphically to each restricted (orthochronous) (n + 1)-dimensional Lorentz matrix a set of N × N-dimensional unimodular matrices, where $N = 2^{n/2}$ or $2^{(n-1)/2}$, depending on whether n is even or odd. In the case n ≥ 2, the theorem is proved that if B(Λ) and $B(\Lambda^T)$ are any two such unimodular matrices associated with Λ and its adjoint Λ^T, respectively then $B(\Lambda^T) = \omega B(\Lambda)$, where ω is an N^{th} root of unity and T means hermitean adjoint. Also it is proven that for n > 3 one can select these two unimodular matrices so that this equation holds with ω = 1, but no such selection is possible for n = 2, 3. (auth)

5648 COMPOUND PARTICLES, CONDITIONS Z = 0, AND BOOTSTRAP. Braun, M. A. (Leningrad State Univ.). Yadern. Fiz., 6: 867-76(Oct. 1967). (In Russian).

The conditions Z = 0 are investigated in the scalar field theory. It is shown that according to the supplementary conditions they correspond either to a general compound particle formalism or to a theory similar to bootstrap. The physical identity of these two theories is considered. (auth)

5649 PROBLEM OF EXISTENCE OF SOLUTIONS IN QUANTUM FIELD THEORY. Wightman, A. S. (Princeton Univ., N. J.). pp 115-43 of Proceedings of the Fifth Annual Eastern Theoretical Physics Conference, Brown University, Providence, November 25–26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-661129.

A review is given of the ideas, methods, and results connected with the problem of proving the existence of solutions in quantum field theory. The existence of solutions of the Schroedinger equation is first discussed; analogous questions in quantum field theory are then considered. The following topics are discussed: physical significance of essential self-adjointness of the Hamiltonian; Kato's theorem for the Hamiltonians of atomic and nuclear physics; statistical mechanics for infinite systems; relativistic theory of charged particles in external fields; cutoff relativistic field theories; essential self-adjointness of the Hamiltonian; existence of vacuum expectation values and Green's functions; and the infinite volume limit in quantum field theory and the thermodynamic limit in statistical mechanics. (L.B.S.)

5650 THIRRING'S FOUR-FERMION MODEL AND THE PERTURBATION THEORY. Astakhov, A. V. (Inst. of Physics and Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 174: 771-4 (June 1, 1967). (In Russian).

Ordinarily in various theoretical field models an exact solution can be obtained only at the price of refusing to specify any basic requirements which any realistic theory must do. In this sense Thirring's model is not actually a model, as its sole limitation is in considering a two-dimensional, relativistically invariant theory of a fermion field of zero mass. The theory is fixed by the density of a lagrangian containing two-dimensional Dirac matrices. The free fields are expressed in formulas. The solution is first obtained in imaginary space H_ψ, in which ψ_i^+ and ψ_i act as generation and annihilation operators, and then the solution is obtained in physical space H_a by a transformation. Covariancy, unitarity and causality are requirements which must be observed. (TTT)

5651 ELEMENTARY PARTICLES IN THE FIELD OF A PLANE ELECTROMAGNETIC WAVE. Fedorov, F. I. Dokl. Akad. Nauk SSSR, 174: 334-6(May 11, 1967). (In Russian).

The equation for a particle in an electromagnetic field has the form: $(\nabla - i\underline{A}_+ m)\psi = 0$ (the charge is included in A). Here $\nabla = (\nabla_l) = \partial/\partial x_l$; $x_4 = ix_0 = ict$; $A = (A_l)$ is the vector potential of the electromagnetic field; $\underline{A} = A_l\gamma^l$; γ^l are the main matrices of the equation. Exact solutions of this equation were obtained in only a few cases. First in the general case the problem is reduced to solving a set of ordinary first-order differential equations for the function $x = x(\phi)$. These equations are converted to a form where they can be solved by means of projection operators. This general approach is used to find solutions for particles having low spins of ½, 0 and 1. Dirac and Duffin–Kemmer algebras are used. In principle the method can also be applied to particles having higher spins, but the absence or complexity of the γ^l matrix algebra makes the calculation difficult. (TTT)

5652 RENORMALIZATION THEORY OF QUANTUM FIELD THEORY WITH A CUT-OFF. Ingraham, R. L. New York, Gordon and Breach Science Publishers, 1967. 193p. $11.20.

The effects on traditional renormalization theory from the incorporation of a fundamental length or high-momentum cut-off into quantum field theory and the ultraviolet divergences of S-matrix elements are eliminated. A first step in such a generalized renormalization theory is presented. The primary interest lies in the physical ideas implied by the cut-off. (J.F.P.)

Gravitation and General Relativity

Refer also to abstract 4923.

5653 A GRAVITATIONAL AHARONOV–BOHM EFFECT. Dowker, J. S. (Univ. of Manchester, Eng.). Nuovo Cim. (10), 52B: 129-35(Nov. 11, 1967).

A flat space-time metric, due to Marder, describing a non-trivial gravitational field is shown to provide a gravitational analog of the Aharonov-Bohm effect which occurs at the classical level. A quantum effect is also briefly discussed. (auth)

5654 ENERGY, SUPERENERGY, AND CONSERVATION LAWS IN GENERAL RELATIVITY. Bonazzola, S. (Univ., Rome). Nuovo Cim. (10), 52B: 187-209(Nov. 11, 1967).

After discussing the observability of the gravitational energy, a gravitational-radiation Poynting pseudovector, constructed with metric coefficients and their first partial derivatives, is proposed. By means of this Poynting pseudovector a definition is given for the difference of gravitational energy of a physical system between two different instants. Such a definition (of course relative to a frame of reference) has satisfactory invariance properties. Two applications are dealt with: the determination of the gravitational energy in the Schwarzschild universe and the determination of gravitational energy between two instants in a geodesic frame of reference. In the latter case it follows a proportionality between the difference of energy and the Bel superenergy tensor. The physical meaning of the superenergy is given. (auth)

5655 PARTICLE WAVE FUNCTIONS IN WEAK GRAVITATIONAL FIELDS. Papini, G. (Univ. of Saskatchewan, Regina). Nuovo Cim. (10), 52B: 136-41(Nov. 11, 1967).

The action of gravitational potentials on particle wave functions is investigated in the weak field approximation. Several gravitational effects can be discussed from a unifying point of view. Of these some may be interpreted as arising from the action of rotation on matter waves. They have an optical analog in the rotation effects studied by Sagnac and Michelson and Gale. Others provide, in principle, ways of testing the general theory of relativity. (auth)

5656 METHOD FOR FINDING THE GENERAL-RELATIVISTIC EFFECTIVE POTENTIAL. Jaen, Jong K. (Univ. of Florida, Gainesville). Phys. Rev., 163: 1361-7(Nov. 25, 1967).

A method of determining exactly the general-relativistic effective potential for a given nongravitational central potential is presented by a formalism based on the extended Hamilton–Jacobi theory of point-particle mechanics to the general-relativistic gravidynamics. The general result is applied to the Newton-gravitational, Coulomb-electrostatic, and Yukawa-nuclear potentials to give further insight. A numerical estimate is made for the gravitational effect superimposed on the original, nongravitational, central potential. (auth)

5657 STATIC AXISYMMETRIC INTERIOR SOLUTION IN GENERAL RELATIVITY. Marek, J. J. J. (Univ. College of Wales, Aberystwyth). Phys. Rev., 163: 1373-6(Nov. 25, 1967).

A class of static, axisymmetric, interior solutions of Einstein's field equations in general relativity is obtained. The solutions are physically reasonable, and can be interpreted as sources for Weyl and Levi-Civita's general exterior solution that is flat at infinity, by making the metric components and their derivatives continuous at the boundary of the matter. For a particular model, a correlation is exhibited between the structure of the source material and the exterior field, which resembles closely, but not exactly, that of the corresponding Newtonian model. (auth)

5658 SCALAR GRAVITATIONAL RADIATION FROM BINARY STARS AND PLANETARY ORBITS. Morganstern, R. E. (State Univ. of New York, Stony Brook, N. Y.). Phys. Rev., 163: 1357-60(Nov. 25, 1967).

The gravitational radiation arising from the relative orbital motion of a two-body gravitationally bound system is analyzed on the basis of the Brans-Dicke theory. This theory predicts radiation by a scalar field as well as the usual tensor field. It is found that for small eccentricities the quadrupole scalar radiation due to the circular component of the orbit is the dominant contribution of the scalar radiation field, and that this is almost a hundred times smaller than tensor quadrupole radiation. (auth)

5659 ISOMETRY GROUPS WITH SURFACE-ORTHOGONAL TRAJECTORIES. Schmidt, Bernd (Univ., Hamburg). Z. Naturforsch., 22a: 1351-5(Sept. 1967).

It is shown that the trajectories of an isometry group admit

orthogonal surfaces if the sub-group of stability leaves no vector in the tangent space of the trajectories fixed. A necessary and sufficient condition is given that the trajectories of an Abelian group admit orthogonal surfaces. In spacetimes which admit an Abelian G^2 of isometries, the trajectories admit orthogonal 2-surfaces if a timelike congruence exists with the following properties: the curves lie in the trajectories and are invariant under G^2; ω^a and u^a are linearly independent and orthogonal to the trajectories. (auth)

5660 TRANSITION FROM THE WAVE OPTICS TO GEOMETRICAL OPTICS IN GENERAL RELATIVITY THEORY. **Ehlers, Juergen (Univ. of Texas, Austin). Z. Naturforsch., 22a: 1328-32(Sept. 1967). (In German).**

The transition from the (covariantly generalized) Maxwell equations to the geometrical optics limit is discussed in the context of general relativity, by adapting the classical series expansion method to the case of curved space time. An arbitrarily moving ideal medium is also taken into account, and a close formal similarity between wave propagation in a moving medium in flat space time and in an empty, gravitationally curved space-time is established by means of a normal hyperbolic optical metric. (auth)

5661 EXTENDED THEORY OF GRAVITATION, MACH'S PRINCIPLE, AND ROTATING MASSES. **Brill, Dieter R. (Yale Univ., New Haven. Univ. of Miami, Coral Gables, Fla.). Z. Naturforsch., 22a: 1336-41(Sept. 1967). (In German).**

The rotation of the local inertial frames induced by a rotating shell of mass is calculated in the framework of P. Jordan's "extended theory of gravitation." As a special case, the corresponding results are obtained for Brans and Dicke's "scalar-tensor" theory. In the weak field approximation the result is the same as the Lense–Thirring effect of general relativity, except for a factor depending on the coupling constant of the scalar field. The strong field limit in which the inertial frame is completely dragged along by the rotating shell is investigated. In particular it is shown that this limit of perfect dragging occurs in certain cosmological models whenever the density of the rest of the matter in the universe tends to zero. This result is interpreted as a manifestation of Mach's principle in the extended theory of gravitation. (auth)

5662 GLOBAL CONNECTIVITY BY TIMELIKE GEODESICS. **Seifert, Hans-Juergen (Univ., Hamburg). Z. Naturforsch., 22a: 1356-60(Sept. 1967).**

The problem of existence of timelike or null geodetic arcs is examined. It is shown that some transparent causality conditions are sufficient for the existence of an extremal geodetic arc between every pair of events joined by a timelike curve. In the case of a complete space-time these assumptions are also necessary. Some applications to the existence of global space-sections and the structure of space-times with a Cauchy surface are given. (auth)

5663 CONSTRUCTION OF EINSTEIN–MAXWELL FIELDS FROM EINSTEIN VACUUM FIELDS. **Enss, Volker (Univ., Hamburg). Z. Naturforsch., 22a: 1361-3(Sept. 1967). (In German).**

A method is discussed for constructing exact solutions of the Einstein–Maxwell equations from vacuum solutions. By means of changes of the metric, the properties of which are listed, one gets all electromagnetic solutions. The transformations and the constructed fields are all given explicitly in terms of the vacuum metric. (auth)

5664 BOUNDARY CONDITIONS THAT ENFORCE MACH'S PRINCIPLE IN GENERAL RELATIVITY. **Katz, A. (Argonne National Lab., Ill.). Nuovo Cim. (10), 51B: 502-13(Oct. 11, 1967).**

It is argued that the boundary conditions that require the line element to degenerate to $ds^2 = c^2dt^2$ at infinity in the spatial co-ordinates enforce Mach's principle in general relativity. Physically this leads to space closure at co-ordinate infinity. (auth)

5665 GEODESIC MOTION IN GRAVITATIONAL FIELD. II. GENERALIZED TOLMAN SOLUTIONS. **Kuchowicz, B. (Univ. of Warsaw). Acta Phys. Pol., 32: 253-69(1967).**

The motion of a test body in an isotropic sphere of fluid is studied in the framework of general relativity. The sphere is described by Tolman's solutions IV, V, and VI (the two latter solutions are applied in their generalized form according to Wyman). Conditions for a stationary motion of massless particles in a bounded region of space (incl. the sphere interior) are derived; also some restrictions of physical type upon the solutions involved are presented. (auth)

Scattering Theory

Refer also to abstracts 5557 and 5631.

5666 A NOTE ON THE THREE-BODY TREATMENT FOR RE-ARRANGEMENT COLLISIONS. **Abul-Magd, A. Y. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim. (10), 52B: 124-8(Nov. 11, 1967).**

A successive procedure based on Faddeev's three-body formulation is presented for calculating the transition amplitude for rearrangement collisions. (auth)

5667 THE DOUBLE N/D METHOD: A NEW APPROACH TO THE CONSTRUCTION OF THE PARTIAL-WAVE AMPLITUDE. **Kinoshita, Kisei (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 38: 705-14(Sept. 1967).**

A method of obtaining the partial-wave amplitude by two steps is proposed, if the amplitude is written as $T = t + r$ where t satisfies the unitarity relation by itself: first t is solved by the N/D method, and then r is solved with the solution of t and the left-hand discontinuity of r as inputs by using the N/D method again. It is proved that the particle pole of T appears in r, not in t. As an interesting application, three examples are discussed: these are the addition of the modified Born term, the channel coupling effects, the effects of the small change of the left-hand discontinuity. For the last case the shifts of the mass and the coupling constant are practically the same as those derived by Dashen and Frautschi, although their derivation is very questionable. (auth)

5668 THE REGGE POLE HYPOTHESIS AND AN EXTENDED PARTICLE MODEL. **Bando, Masako (Kyoto Univ., Japan); Inoue, Takeshi; Takada, Yoshio; Tanaka, Sho. Progr. Theor. Phys. (Kyoto), 38: 715-32(Sept. 1967).**

Yukawa's bi-local field is investigated as a simple model for an extended particle and is quantized so as to represent the Regge pole behavior. Two characteristic aspects of elastic scattering at high energies, the diffraction pattern near the forward direction and the compound elastic type of scattering at large angle are explained in a unified way, i.e., the former is explained by the exchange of this extended particle with a space-like four-momentum and the latter by the occurrence of this particle with a time-like four-momentum in the intermediate state of scattering. The difference is emphasized which is due to whether the particle under consideration propagates with a space-like or a time-like four-momentum, in reference to the validity of Fierz's postulate on Yukawa's bi-local field. (auth)

5669 INTEGRAL CONCEPT OF AMPLITUDE OF SCATTERING BASED ON MELER–DIRICHLET INTEGRAL. **Arushanov, G. G. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 9, 23-6(1967). (In Russian).**

Previously it was found that the integral concept of scattering amplitude obtained by interchanging Legendre polynomial by their integral concept using the Bessel function was more advantageous than the ordinary reduction by the Legendre polynomial series. An attempt is made to apply another integral of the scattering amplitude concept based on the Meler-Dirichlet integral. (R.V.J.)

5670 REGGEIZED BOOTSTRAP OF THE K* MESON. **Vasavada, Kashyap V. (Univ. of Connecticut, Storrs); Nath, Pran; Srivastava, Y. N. Phys. Rev., 163: 1815-19(Nov. 25, 1967).**

A bootstrap of the K* meson is attempted in the Kπ channel via a representation due to Abbe, Kaus, Nath, and Srivastava. Here a total amplitude is constructed purely in terms of Regge trajectories, and crossing is used to determine the parameters. An unknown coupling constant $G_{\rho K\bar{K}}$ enters the calculation. When its SU(3) value is taken, the bootstrapped values are $m_{K^*} = 960$ MeV (experimental value is 890 MeV) and $\Gamma_{K^*} = 28$ MeV (experimental value is 50 MeV). When for $G_{\rho K\bar{K}}$ two times its SU(3) value is chosen, a simultaneous bootstrap of m_{K^*} and Γ_{K^*} occurs at the experimental value. The S-, P-, and D-wave phase shifts are plotted for the Kπ system in the low-energy region. The scattering lengths for $I = \frac{1}{2}$ S and P waves are found to be: $a_0 \approx -0.078$ and $a_1 \approx +0.017$. (auth)

5671 FACTORIZATION OF REGGE AND TOLLER POLES. **Taylor, J. C. (Oxford Univ.). Nucl. Phys., B3: 504-10(1967).**

If singularities at $t = 0$ in a Regge amplitude are cancelled by a series of daughter or conspirator trajectories, the minimum set of couplings consistent with the factorization of all the residues sums to a Toller pole. There must, however, be correction terms which change the sign of half the residues. (auth)

5672 RELATIONS AMONG THE SUPERCONVERGENCE CONDITIONS FOR FORWARD ELASTIC SCATTERING. I. SCATTERING OF A SPINLESS PARTICLE BY A PARTICLE WITH ARBITRARY SPIN. **Lin, Keh Ying (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 163: 1568-72(Nov. 25, 1967).**

The relations among the superconvergence conditions for the

forward elastic scattering of a spinless particle by a particle with arbitrary spin are discussed. Because of the existence of identities among the t-channel helicity amplitudes at t = 0, the corresponding superconvergence conditions are not independent of each other. In general, there are several t-channel helicity amplitudes which have the same s-kinematic factors; it is shown that only one of them needs to be investigated. However, the superconvergence conditions which are derived from the t-channel helicity amplitudes with different kinematic factors are not related to each other. (auth)

5673 KINEMATICS OF PRODUCTION PROCESSES AND THE MULTI-REGGE-POLE HYPOTHESIS. Bali, N. F.; Chew, Geoffrey F.; Pignotti, Alberto (Univ. of California, Berkeley). Phys. Rev., 163: 1572-81(Nov. 25, 1967). (UCRL-17530).

Toller's group-theoretical analysis of multiparticle scattering amplitudes, which leads naturally to a Regge-pole-type expansion, is extended to give a precise meaning to the multi-Regge-pole hypothesis. An essential step in this direction is achieved by the introduction of generalized Toller variables, which are tailored to the description of the asymptotic behavior of a production process in several subenergies. (auth)

5674 SIMPLIFIED PROCEDURE FOR PERFORMING ABSORPTION CORRECTIONS. Kane, G. L. (Univ. of Michigan, Ann Arbor). Phys. Rev., 163: 1544-8(Nov. 25, 1967).

An approximate procedure for carrying out absorption corrections is presented. It is simpler to apply than the usual procedure, in that the impact-parameter integrals are replaced by simple factors. One can perform the absorption corrections directly on the helicity amplitudes, without performing a partial-wave expansion. The procedure allows one to reproduce approximately all of the results of the usual method, including the polarizations of the produced particles, with only the parameters present in the usual approach. (auth)

5675 FOUR-MASS KINEMATICS FOR REGGE CROSSING. Sakmar, Ismail A.; Wojtaszek, Joseph H. (Univ. of Miami, Coral Gables, Fla.). Phys. Rev., 163: 1748-53(Nov. 25, 1967).

The kinematics of two-particle-to-two-particle scattering are investigated for the purpose of Regge crossing. The boundaries of the physical regions for all three channels are given by a single equality, $|z_s| = |z_t| = |z_u| = 1$, which is not the case for two different-mass and four equal-mass processes. In both the s and u physical regions, $|z_t|$ is larger than or equal to 1, and has a maximum whose value increases with increasing energy. At the same time, the position of this maximum approaches the forward direction as the energy increases. (Similar statements can be made about z_s in the t and u channels, and z_u in the s and t channels.) There exist three singular points in either the forward or backward directions for two channels at definite scattering energies for which one of z_s, z_t, or z_u is indeterminate. (auth)

5676 PROPERTIES OF FREEDMAN-WANG AMPLITUDES. Schwarz, John H. (Princeton Univ., N. J.). Phys. Rev., 163: 1697-9(Nov. 25, 1967).

The analytically-continued O(4) amplitudes of Freedman and Wang are studied for spinless scattering. It is shown that as a consequence of the absence of Gribov-Pomeranchuk poles in the J-plane amplitudes at right-signature nonsense points, the O(4) amplitudes have the symmetry properties required to carry out the analog of the Mandelstam form of the Sommerfeld-Watson transformation. The contribution of a single Lorentz pole to asymptotic behavior is then considered, and it is suggested that in a slightly modified form it may be useful for extending Regge analysis to lower energies. (auth)

5677 CALCULATION OF DAUGHTER TRAJECTORIES. Cutkosky, R. E.; Deo, B. B. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev. Lett., 19: 1256-8(Nov. 20, 1967).

Explicit calculations show that daughter trajectories are very model dependent. It is therefore necessary to be cautious in applying Lorentz symmetry when the energy is not zero. (auth)

5678 ANALYTICITY PROPERTIES AND ASYMPTOTIC BEHAVIOR OF SCATTERING AMPLITUDES. Jin, Y. S. (Brown Univ., Providence). pp 145-66 of Proceedings of the Fifth Annual Eastern Theoretical Physics Conference, Brown University, Providence, November 25-26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967. (NYO-2262TA-146).

See CONF-661129.

A review is given of some recent developments in the study of the analyticity properties of scattering amplitudes in local field theory and some immediate applications of these properties to obtain their asymptotic behavior. (L.B.S.)

5679 RECENT DEVELOPMENTS IN REGGE POLE THEORY. Goldberger, M. L. (Inst. for Advanced Study, Princeton, N. J.). pp 167-77 of Proceedings of the Fifth Annual Eastern Theoretical Physics Conference, Brown University, Providence, November 25-26, 1966. Feldman, David (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-661129.

A discussion is given on some developments in Regge pole theory, both from the standpoint of high-energy scattering theory and for the classification and systematization of particle spectra. Its relevance to discussions of superconvergence relations emerging from current algebra theory is also pointed out. (L.B.S.)

Particle Accelerators

Refer also to abstracts 4455, 4853, 5094, and 5095.

5680 (AERE-R-5205) PHYSICS OF THE SUPERBOOSTER. Constantine, G.; Crocker, V. S.; Jones, R. H.; Poole, M. J.; Robinson, A. H.; Ruffle, M. P. (Atomic Energy Research Establishment, Harwell (England)). June 1967. 72p. Dep. CFSTI. UK 10s. 0d.

The physics aspects of the Superbooster, which is an extension of the Harwell Neutron Booster, are discussed. The Harwell Neutron Booster comprises a pulsed electron linear accelerator which generates neutrons in a heavy target and a subcritical fast reactor core surrounding the target which multiplies the neutrons. The main differences being an increase in beam power with increases in both energy and current, a considerable increase in the multiplication factor, higher core power, lengthened power pulse, and greater interpulse background due to delayed neutrons. The physics aspects discussed are the kinetics of the core power, time-dependent neutron spectra emerging from moderator boxes, fluxes available at output faces of moderator chamber and pulse lengths for a number of spot neutron energies under a wide range of conditions of linac pulse length, superbooster multiplication, pulse repetition frequency, and size and temperature of the moderator chamber. An experimental program mounted on the fast critical assembly VERA is described and results presented. (B.G.D.)

5681 (BNL-11762) SOME EXTENSIONS OF COMPLEX METHODS FOR TWO-DIMENSIONAL FIELDS. Beth, Richard A. (Brookhaven National Lab., Upton, N. Y.). [1967]. 10p. (CONF-670930-19). Dep. CFSTI.

From 6th International Conference on High Energy Accelerators, Cambridge, Mass.

Useful extensions of complex methods for dealing with static two-dimensional fields are obtained by identifying pairs of Maxwell equations with the Cauchy-Riemann conditions for an analytic function. (auth)

5682 (CEAL-1037) RF BEAM DYNAMICS IN THE CEA STORAGE EXPERIMENT. Dekleva, J.; Nicholls, G. L. (Cambridge Electron Accelerator, Mass.). Aug. 17, 1967. Contract AT(30-1)-2076. 12p. Dep. CFSTI.

Differential equations are presented to relate the beam and the rf accelerating system of the CEA. Calculations to describe the rf parameters necessary to produce a 3-GeV beam of 100 mA are presented and discussed. (W.H.K.)

5683 (DESY-67/29) DER EINFLUSS VON TARGETDICKE UND KOLLIMATION AUF DAS BREMSSPEKTRUM IM GeV-BEREICH. (The Effect of Target Thickness and Collimation Angle on the Bremsstrahlung Beam in the GeV Region). Lutz, G.; Schulz, H. D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sept. 1967. 34p. (In German). Dep.

A calculation of the effects of target thickness and collimation angle on the intensity and the spectral distribution of a bremsstrahlung beam is presented. The beam is assumed to have been produced by electrons with energies in the region 1 to 6 GeV. The results are compiled in tables, permitting interpolation for other arrangements. (auth)

5684 (NP-17020) EXPERIMENTELLE UNTERSUCHNGEN ZUR BREITBANDANPASSUNG VON BESCHLEUNIGUNGSELEKTRODEN BEI TEILCHENBESCHLEUNIGERN. (Experimental Investigations on Broad-Band Adaptation of Acceleration Electrodes for Particle Accelerators). Moehl, Dieter (Freie Universitaet, Berlin (West Germany)). [1966]. 17p. (In German). Dep.

Thesis.

A broad-band hf system is used for particle accelerators with magnetic fields, which are constant in time, and varying frequency. For broad-band adaptation, a network of RLC elements, cables, and cavity resonators were connected between the power amplifier and the acceleration electrodes. The possibilities and limitations on the reduction of the power requirements with broad-band adaptation were investigated. The maximum attainable power

ratios were determined independently of the frequency characteristics of the network. Studies were made to determine how a given network with known characteristics is optimized. Criteria for the selection of the optimum frequency characteristics were given. The most favorable power ratios are obtained with networks with strong frequency-dependent transmission characteristics. In the comparison of the various types of networks, the working conditions of the amplifier must be considered. With a model system for a 150-MeV FFAG electronsynchrotron, a three-circuit system with 12 db pulse height of the transmission characteristic and an optimum adaptation system with flat characteristics were compared, and their utility in the accelerator was tested. The results showed that an improvement of the power was possible by adaptation of the frequency characteristics to the hf program of the accelerator. (J.S.R.)

5685 (NP-17071) MESSUNG UND KORREKTUR EINES MAGNETFELDES MIT KONSTANTEM FELDINDEX IN RADIALER RICHTUNG. (Measurement and Revision of a Magnetic Field with Constant Field Index in a Radial Direction).* Arendt, Friedrich (Freie Universitaet, Berlin (West Germany). I. Physikalisches Institut). 1966. 64p. (In German).

Magnetic field measurements on a two-sector model of a FFAG electron synchrotron were described and evaluated. The magnetic field was measured in the medium plane of the sector using a rotating coil. The positioning of the probe was established accurately to ±0.1 mm. The induction voltage at the end of the coil was converted to a series of pulses of variable frequency using a measuring amplifier and a voltage frequency converter. The resolution of the measurement arrangement was better than 5×10^{-4} and the measurement time was held constant to at least 10^{-5} with an electronic clock. The error of the counter rise is between 5×10^{-4} and 1×10^{-3} and is caused by an uncertainty of ±1.0 pulse in the counting, the noise of the amplifier, and the oscillations of the net frequency which is transmitted over a synchronous motor to the coil. In measurements of the field index k, the coil was introduced along the medium line of a partial sector, (radial direction). K was measured as a function of the radius. Deviations up to 15% of the predicted values occurred. By additional windings the pattern of k(r) in a partial sector was corrected so that in the radius region of interest $|k(r) - 8| < 0.16$. In measurements of the field pattern in the azimuthal direction the coil was placed along a circular arc. The field pattern measured in the azimuthal direction was developed in a Fourier series. The Fourier component show, especially in the pole shoe region a strong dependence on the radius which is caused by the special form of the pole shoe. Measurements with side excitation, in which the pole is lacking, show a deviation of the Fourier component of less than 2% over the radius. In studies of the field pattern as a function of the excitation intensity the effect of the saturation of the ion is shown in a modification of k(r). The operation of the electronic clock was explained and its circuits were given in an appendix. (tr-auth)

5686 (NP-17079) UNTERSUCHUNGEN AN EINEM MAGNETMODELL FUER EIN FFAG-ELEKTRONENSYNCHROTRON. (A Magnet Model of a FFAG-Electron Synchrotron). von Schaewen, Juergen (Freie Universitaet, Berlin (West Germany). I. Physikalisches Institut). 1967. 48p. (In German).

Magnetic field measurements on a two-sector model of a FFAG electron synchrotron were described. The field was measured at points by means of a rotating coil. The induction voltage produced was converted into frequencies which were counted during a given measurement time. Since the evaluation of the measurement was made by an electronic computer, the measurement values must be transferred to the data carrier. Therefore a teleprinter-control device was developed which elicits measurement values, prepares the corresponding teleprint code, and controls a sealed teleprinter. In measurements in the radial direction the coil was placed along a radius. From the measured field distribution the field index k was determined. The effect of the positioning of the excitation windings, individual excitation, total excitation, and excitation ratios was investigated. In measurements in the azimuthal direction, the coil was placed along a circular arc. The measured field pattern was developed in a Fourier series. The magnitude and radius dependence of the Fourier coefficients g_n were determined and improved by corrections. The coefficients obtained and their deviations are $g_0 = 0.098 \pm 0.003$, $g_1 = 0.898 \pm 0.002$, $g_2 = 0.002 \pm 0.002$, $g_3 = 0.001 \pm 0.003$, and $g_n = 0 \pm 0.002$, where $n > 4$. (tr-auth)

5687 (UCRL-17862) ENERGY EXPANSION OF THE 200-GeV ACCELERATOR TO 400 GeV AND ABOVE BY CONSTRUCTION OF A SUPERCONDUCTING GUIDEFIELD. Green, Michael A. (California Univ., Berkeley. Lawrence Radiation Lab.). July 14, 1967; Revised Aug. 4, 1967. Contract W-7405-eng-48. 23p. Dep. CFSTI.

This report proposes to extend the energy of the 200-GeV accelerator to higher energies by the addition of a superconducting synchrotron. The feasibility of such a system is discussed and cost estimates are made on a number of superconducting accelerator systems. Two basic types of machines are analyzed: a standard cycle accelerator system, and an accelerating storage ring system. Cost estimates are made on all of the major accelerator components and the conventional facilities. The effect of machine parameters on cost is shown. (auth)

5688 RELATIVISTIC CHARGE RADIATION IN ELECTROMAGNETIC FIELD OF THE PLANAR WAVE. Ternov, I. M.; Bagrov, V. G.; Khapaev, A. M.; Klorovskii, K. S. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 8, 77-84(1967). (In Russian).

Questions on the irradiation of charged particles during their motion in electromagnetic fields of planar waves were investigated by classical and quantum theory methods. Circular polarization was assumed for the electromagnetic waves. (tr-auth)

5689 THE STORAGE RING. LOW BUDGET ROAD TO HIGHER ENERGY PHYSICS. Davis, Harold L. Sci. Res., 2: No. 12, 48-50; 52; 54(Dec. 1967).

A survey of the development and present status of colliding-beam storage rings is presented. The advantages and disadvantages and the expectations and limitations of the colliding-beam concept are discussed. Storage rings now in operation and proposed storage rings are described. (W.H.K.)

5690 LONG-LIVED TARGETS FOR NEUTRON GENERATORS. Jessen, P. L. (Kaman Nuclear, Colorado Springs, Colo.). Trans. Amer. Nucl. Soc., 10: 452(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

5691 THE IPCR CYCLOTRON. Matsuda, Kazuhisa; Karasawa, Takashi. Nippon Genshiryoku Gakkaishi, 9: 656-7 (Nov. 1967). (In Japanese).

A cyclotron of the conventional type was built at the Institute of Physical and Chemical Research (Saitama-ken, Japan). Its particular features include capacity for accelerating to a wide range of beam energies a large variety of particles, including heavy ions. The significance of the establishment of this installation is discussed, and the construction of many more accelerators in this country is recommended. Special problems involved in the utilization of the cyclotron in applications other than nuclear physics are described. (auth)

5692 RADIAL SHAPING OF A BEAM IN AN ELECTRON LINEAR ACCELERATOR. Dem'yanenko, G. K.; Kolesnikov, L. Ya.; Miroshnichenko, I. I. Zh. Tekh. Fiz., 37: 1219-24 (July 1967). (In Russian).

The experience in shaping an electron beam cross section in a 360-MeV linear accelerator is discussed. It was found experimentally that instead of a circle less than 0.6 cm in diameter, the output beam cross section has a shape of a distorted oval about 1.0×2.5 cm. The considerable level of gamma radiation indicated also that electrons scatter on the inner surfaces of the accelerator. They eliminated insufficient magnetic shielding as a possible source after painstaking measurements of the magnetic field levels on the axis of the accelerator along its whole length (50 meters) with a specially designed magnetometer. The actual cause was shown to be the insufficient axial symmetry of the high-frequency field in the coupling wave transformers between the accelerating sections. Satisfactory beam shaping was achieved with the help of an additional focusing system of quadrupole lenses and clearing collimators which reduced the beam diameter at the output of the accelerator to 0.5-0.6 cm with an angular divergence of $\sim 10^{-4}$ radian. This additional focusing also reduced the electron scattering inside the accelerator and, consequently, the gamma-radiation background. In the bremsstrahlung radiation from thin targets the gamma-background radiation was reduced from 20-25% to 0.1% at an electron energy of 200 MeV. (ATD)

5693 A FORMULA FOR THE INCREASE IN THE ENERGY OF PARTICLES IN A UNIFORM STRUCTURE WITH TRAVELING WAVES, WITH THE LOADING BY THE BEAM CURRENT TAKEN INTO ACCOUNT. Shal'nov, A. V.; Koroza, V. I.; Volodin, V. A. Zh. Tekh. Fiz., 37: 1225-9(July 1967). (In Russian).

The motion of a uniform sequence of charged particle bunches (treated as point charges) through a uniformly loaded system (waveguide) carrying a traveling wave, taking into account the effect of the radiation field induced in the loaded system by the motion of the charged particles is discussed. The calculations are performed separately for the cases when the group velocity of the waves in the loaded system is positive, and when the group velocity is zero. Formulas are derived for the increase in the

energy of the particles during their motion through one section of the loaded waveguide under steady state conditions, and the energy increment is expressed in terms of the potential across an equivalent accelerating gap. The relatively simple formulas should be useful in the design of cyclic accelerators. The formula for the particle energy increment per section reduces in the case when the particle velocity is equal to the phase velocity of the traveling wave and the decrement per wavelength of the traveling wave is small to the formula given by J. E. Leiss (IEEE Trans., NS-12, No. 3, 1965). (ATD)

5694 CONSTRUCTION OF THE GUIDE FIELD FOR A LOW INDUCTANCE AIR-CORE PLASMA BETATRON. **Ferrari, L. A.; Rogers, K. C.; Jermakian, A. (Stevens Inst. of Tech., Hoboken, N. J.). Rev. Sci. Instrum., 38: 1697-1702(Dec. 1967).**

The guide field for a low inductance (55×10^{-9} H) air-core plasma betatron is constructed by placing flux-concentrators within the interior of a single-turn solenoid. The betatron field coil is energized by the discharge of a 75 μF, 20 kV capacitor bank. The quarter period of the field-coil capacitor bank system is 4 μsec and the peak magnetic and electric fields at the equilibrium orbit ($r_0 = 4.83$ cm) are ≈3250 G and 60 V/cm, respectively. Techniques used to make accurate (±0.1%) measurements of transient magnetic field distributions are also described. (auth)

5695 QUADRUPOLE MAGNET MISALIGNMENT TOLERANCES. **Meads, Philip F. Jr. (Midwestern Universities Research Association, Stoughton, Wis.). Rev. Sci. Instrum., 38: 1752-6(Dec. 1967).**

The field produced by a quadrupole magnet is antisymmetric with respect to reflection through either of two orthogonal planes whose intersection is the optical axis of the magnet. Failure to perfectly align these planes for a given quadrupole magnet with the cardinal planes of the beam system incorporating that magnet induces an error field that perturbs the beam. The effects of misalignments of a number of quadrupoles are derived by including the induced error fields in the equation of motion. The results are expressed in terms of the known linear optical properties of the beam system and are sufficient for determining the tolerances required on each constituent quadrupole magnet. (auth)

5696 EXPERIMENTS WITH A TARGET IN THE ELECTRON STORAGE RING. **Budker, G. I.; Onuchin, A. P.; Popov, S. G.; Tumaikin, G. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz., 6: 775-9(Oct. 1967). (In Russian).**

Calculations are carried out for the experiments with the electron (positron) storage rings. Thin and superthin targets and the angular and energy dispersion of the particles were considered. (auth)

5697 INDUSTRIAL APPLICATIONS OF ELECTRON ACCELERATORS. **Gantt, E. D.; Trageser, D. A. (High Voltage Engineering Corp., Burlington, Mass.). J. Brit. Nucl. Energy Soc., 6: 337-42(Oct. 1967).**

The industrial use of electron accelerators has, since its inception ten years ago, reached a level of 300 kW installed power and is growing at the rate of 20% per year. An historical review is presented on how increased accelerator power has reduced processing costs in the past several years, and how equipment now in development will reduce these costs still further. Radiation systems in use today in the plastics film and tubing, textiles, wood, and metal products fields are described with emphasis on process and radiation costs. New developments in accelerator systems and shielding, along with product handling equipment and their impact on the future, are evaluated. (auth)

5698 DESCRIPTION OF A LAMB-SHIFT POLARIZED ION SOURCE INSTALLED ON A TANDEM ACCELERATOR. **Clegg, T. B.; Plattner, G. R.; Keller, L. G.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Instrum. Methods, 57: 167-70(Dec. 1967).**

A source of polarized negative ions which uses the hydrogen metastable $2S_{\frac{1}{2}}$ state was constructed and installed on a tandem accelerator. Performance figures for proton and deuteron beams are given. (auth)

5699 A COMPACT SOURCE OF POLARIZED IONS FOR PRESSURIZED VAN DE GRAAFF ACCELERATORS. **Barit, I. J.; Vasil'ev, G. A.; Glasov, E. A.; Jolkin, V. V. (Lebedev Inst. of Physics, Moscow). Nucl. Instrum. Methods, 57: 160-2(Dec. 1967).**

A compact source of polarized protons and deuterons is described which is to be installed in the high voltage terminal of a standard-size pressure tank Van de Graaff accelerator. (auth)

5700 STUDY AND REALIZATION OF A PULSING SYSTEM FOR A PARTICLE BEAM WITH A VIEW TO MEASURING THE LIFETIME OF EXCITED NUCLEAR STATES. **Gorodetzky, S.; Gerber, J.; Vivien, J. P.; Macher, A.; Armbruster, R. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Instrum. Methods, 57: 152-5(Dec. 1967). (In French).**

A microwave beam pulsing system was developed and tested with a proton beam from a Van de Graaff accelerator. The bunched protons have a length of about 3×10^{-11} s. This timing apparatus when combined with a second microwave cavity which serves as an analyzer should allow timing measurements of the order of 10^{-10} to 10^{-11} sec. The electric field which is located between the gaps of the two microwave cavities has a constant amplitude and range. The magnitude of the deflection of the pulsed beam depends on the transit angle of the gap. The instabilities of the beam energy and the phasing between the two cavities correspond to a phase error which is less than 5° or 6×10^{-12} sec. (auth)

5701 MICROAMPERE NEGATIVE HELIUM IONS USING POTASSIUM VAPOR EXCHANGE. **John, Joseph; Robinson, C. P.; Aldridge, J. P.; Wallace, W+ J.; Chapman, K. R.; Davis, R. H. (Florida State Univ., Tallahassee). Nucl. Instrum. Methods, 57: 105-8(Dec. 1967).**

Modification of the ion source of a model EN tandem Van de Graaff accelerator to utilize potassium vapour charge exchange has increased the negative helium ion currents to 2.0 μA. Alpha-particle beam currents used in experiments depend on the transmission through the machine and vary from 0.3 to 0.8 μA. The modified source has been used with potassium vapour exchange for continuous periods of up to three weeks. No upper time limit has been established. (auth)

5702 MOLTEN METAL PROTON TARGET ASSEMBLY. **Stanton, Richard Myles (to Secretary of the Army). U. S. Patent 3,349,001. July 22, 1966.**

Design of a molten-lead target assembly for accelerated nuclear particles is presented. A fertile nuclear material is placed in the immediate vicinity of the target area for additional reactions. (TSS) (U. S. Pat. Gazette)

5703 QUADRUPOLE MAGNET. **Sampson, W. B.; Britton, R. B.; Kruger, P. G. (to U. S. Atomic Energy Commission). U. S. Patent 3,356,976. Dec. 5, 1967.**

High-field, high-current density, multipole magnets with current sheets formed from superconducting ribbons are described. Specific configurations of quadrupole magnets for transporting charged particles are also described. Provisions are made for effectively cooling the superconductor ribbon and for reducing localized current degradation therein. (AEC)

5704 RESONATOR FOR SUPPORTING NONSINUSOIDAL PERIODIC WAVEFORMS. **Kerns, Quentin A. (to U. S. Atomic Energy Commission). U. S. Patent 3,359,452. Dec. 19, 1967.**

A high-frequency cavity resonator having harmonically related resonance frequencies is described. The configuration of the resonator may take a variety of forms however, in each form the impedance variation along a gap between two of the principal conducting elements follows a definite pattern. By supporting harmonically related frequencies, non-sinusoidal waveforms may be excited in the cavity and used, for instance, as a function generator or to accelerate, separate, or extract a particle beam in an accelerator. (AEC)

5705 HIGH-VOLTAGE GENERATOR. **Crewe, Albert V.; Yokosawa, A.; DeGeeter, Dale J. (to U. S. Atomic Energy Commission). U. S. Patent 3,360,663. Dec. 26, 1967.**

A high-voltage generator is described. A Faraday cup is mounted in electrical connection with one of two electrodes spatially disposed with respect to each other in a partial vacuum. Means are provided for generating and directing an electron beam into the Faraday cup, whereby a negative charge accumulation occurs on the electrode having the Faraday cup attached thereto and a high voltage is developed between the two electrodes. (AEC)

5706 ELECTRON ACCELERATOR MEANS WITH MEANS FOR REPEATEDLY PASSING THE INITIAL ELECTRONS THROUGH THE ACCELERATOR. **Crowley-Milling, Michael Crowley (to Associated Electrical Industries Ltd.). U. S. Patent 3,349,335. Aug. 31, 1964. Priority date Sept. 3, 1963, Great Britain.**

An electron accelerator is described which is composed of a linear accelerator section, deflecting magnets adapted to deflect electrons leaving the outlet end of the linear accelerator section back to the inlet in re-entrant paths, means for introducing fresh electrons from an electron source laterally into the main electron stream approaching the inlet end of the linear accelerator, deflecting means for imparting a forward velocity component to said fresh electrons, compensating magnetic means adapted to impart a compensating deflection to a main stream of electrons prior to said electrons entering the field of said deflecting magnets to cause all the electrons to pass from said deflecting magnets in substantially the same direction. (U. S. Pat. Gazette)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 5408, 5440, 5680, 5811, and 5817.

5707 (BARC-294) PREPARATION OF PLUTONIUM-BERYLLIUM ALLOY NEUTRON SOURCE. Roy, P. R.; Deshpande, R. G.; Laxminarayanan, T. S. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 12p. Dep.

The preparation and evaluation of a Pu-Be source with an average output of 1.85×10^6 n/sec are described. The Pu-Be alloy was obtained by mixing powders of PuO_2 and Be, pressing the mixture into pellets, and reducing the PuO_2 to Pu by heating the pellets in an induction furnace. The exposures received by the personnel who prepared the source were evaluated. (D.C.W.)

5708 (RISO-144) MEASUREMENT OF THERMAL NEUTRON BEAM DENSITIES. I. PRECISION MEASUREMENT USING A ^{3}He PROPORTIONAL COUNTER. II. CORRECTIONS TO THE GOLD FOIL ACTIVATION METHOD FOR DETERMINING NEUTRON BEAM DENSITY. Als-Nielsen, J. (Danish Atomic Energy Commission, Risoe. Research Establishment); Bahnsen, A. (Rochester Univ., N. Y.); Brown, W. K. (Los Alamos Scientific Lab., N. Mex.). Dec. 1966. 57p. Dep.

A new method, based on the ^{3}He(n,p)T reaction, was developed for the accurate determination of thermal neutron beam densities. Several comparisons were made with the conventional Au foil activation method, and agreement was obtained between the two methods within an experimental uncertainty of ±0.4%. Fundamental advantages of the method include the 1/v dependence of the ^{3}He (n,p)T cross section up to 1 keV, and the assurance of homogeneity even for very small macroscopic cross sections because of the gaseous detector material. Although the method requires a relatively clean neutron beam, it can be used over a wide range of neutron densities and, in particular, is capable of measuring extremely weak beams. A detector was constructed which has a well-defined efficiency and is able to accept beams of diameters up to 10 cm. The ^{3}He counter method is proposed as a precision standard for the absolute measurement of thermal neutron beam densities. Finite foil thickness and deviation of the cross section from the 1/v law imply corrections in the determination of neutron beam densities by means of foil activation. These corrections, which depend on the neutron velocity distribution, were examined in general and are given in a specific example for a reactor beam transmitted through a 30-cm Bi filter. The effective cross section differs 0.5% from the capture cross section at 2200 m/s. For a 20 mg/cm^2 Au foil the correction for beam attenuation and hardening through the foil is 0.7%, and the activity correction is 1.5%. (auth) (DENMARK)

5709 (RPI-328-102) EPITHERMAL NEUTRON INELASTIC SCATTERING BY POLYETHYLENE. Moore, W. E.; Kirouac, G. J.; Esch, L. J.; Seemann, K. W. (Knolls Atomic Power Lab., Schenectady, N. Y.); Yeater, M. L. (Rensselaer Polytechnic Inst., Troy, N. Y.). [1967]. Contracts W-31-109-eng-52; AT(30-3)-328. 10p. (CONF-671028-3). Dep. CFSTI.

From 2nd Symposium on Materials Research: Molecular Dynamics and Structure of Solids, Gaithersburg, Md.

Double differential scattering data were obtained for a thin sample of high density polyethylene at room temperature, using the RPI-KAPL neutron spectrometer. Incident neutron energies in the range 0.1 to 1 eV are used, permitting a wide range of energy and momentum exchange to be studied. Evidence was seen in the data for known vibrational states between 0.09 and 0.18 eV, and at 0.36 eV. In addition, scattering from the acoustic modes for torsional and stretch-bend carbon chain vibrations was observed. Some initial comparisons with theoretical models were made. (auth)

5710 (WAPD-T-2015) SPATIAL DISTRIBUTIONS IN A ZIRCONIUM-WATER LATTICE OF ACCELERATOR SOURCE NEUTRONS. Stooksberry, R. W.; Goldsmith, M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sept. 1967. Contract AT(11-1)-Gen-14. 6p. (CONF-671102-37). Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

Neutron slowing down in a Zr-H_2O lattice assembly was investigated using an array of parallel zirconium slabs in a tank of water. The indium resonance activation was measured at the midpoint of the water gap (0.987 cm) between slabs for both 2.85-MeV T(p,n)^{3}He and 2.185-MeV D(d,n)^{3}He neutron sources. The indium resonance was obtained by positioning 0.005-in.-thick In-Sn foils with 0.020-in. Cd covers in planes at a distance Z forward of the accelerator target and perpendicular to the ion beam axis. The integral activation was obtained by integration of these data as well as an extrapolated region to infinity. (D.C.W.)

5711 ASYMPTOTIC PROPERTIES OF THE NEUTRON ENERGY DISTRIBUTION DURING NEUTRON MODERATION IN AN INFINITE MEDIUM. Uvarov, V. B. Zh. Vychisl. Mat. Mat. Fiz., 7: 836-51(July-Aug. 1967). (In Russian).

The finding of a neutron energy distribution function reduces to solving the following integral equation: $\psi(u) = \int_0^u \psi(u')\, h(u')\, f(u-u')\, du' + Q(u)$. Q(u) is a term proportional to the rate of neutron generation, and h(u) is the ratio of the effective neutron scattering cross section to the total neutron interaction cross section with the moderator. It is shown that with definite limitations on h(u) there exists a limit $\psi_1(u)/\psi_2(u)$ as $u \to \infty$. Thus the procedure of determining the function $\psi(u)$ can be substantially simplified. If it can be assumed that no neutron sources exist at $u > u_0$, then Q(u) = 0. If the function $\psi(u)$ is of interest at $u \gg V_0$, it turns out that in this case it is not necessary to solve the above neutron energy distribution equation at $0 < u < u_0$. The results are generalized to the case of neutron moderation in a medium consisting of a number of substances. (TTT)

5712 CALCULATING DERIVATIVE FUNCTIONALS BY A MONTE CARLO METHOD FROM A SOLUTION OF THE TRANSFER EQUATION ACCORDING TO THE SYSTEM PARAMETERS. Mikhailov, G. A. Zh. Vychisl. Mat. Mat. Fiz., 7: 915-9(July-Aug. 1967). (In Russian).

The integral transfer equation can be written in the form: (1) $F(x) = \int_x k(x' \to x)\, F(x')\, dx' + f(x)$ or $F = KF + f$. Here X is the phase space of coordinates and velocities; F(x) is the density of collisions at point x; $k(x' \to x)$ is the density of "primary" collisions at point x from a "single" collision at point x', and f(x) is the density of neutron sources. It is assumed that the solution of the above equation can be represented in the form of a Neiman series: $F = f + \sum_{n=1}^{\infty} K^n f = \sum_{n=0}^{\infty} K^n f$. Various integral characteristics of the transfer process can be represented in the form of linear functionals from a solution of equation 1. The functional can be estimated by a Monte Carlo method for various values of the system parameters by by using the same particle trajectory. In this way, no distortions are introduced by the use of weighted multipliers. Let $k(x' \to x) = k(x' \to x, \lambda)$, where λ is a certain parameter of the system. Then the trajectory constructed for $\lambda = \lambda_0$ can be used for estimating the functional $I_\phi(\lambda)$, if after each transfer $x' \to x$ the auxiliary "weight" of the particle is multiplied by the term $k(x' \to x, \lambda)\, k(x' \to x, \lambda_0)$. The method is used to calculate derivatives of the effective multiplication coefficient and the neutron multiplication time. (TTT)

5713 ON THE FORM OF ENERGY DISTRIBUTION OF THE ONE-QUANTUM SCATTERING OF NEUTRONS. Kashcheev, V. N. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 4, 26-30(1967). (In Russian).

With the help of the Kubo-Tomita method, the energy distribution of the one-quantum coherent scattering of neutrons was investigated. (auth)

5714 RESONANCE INTEGRAL CALCULATIONS TREATING OVERLAP AND INTERFERENCE. Helholtz, J.; Roy, D. H. (Babcock and Wilcox Co., Lynchburg, Va.). Trans. Amer. Nucl. Soc., 10: 579(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

5715 THE EFFECT OF HEAVY-ELEMENT SCATTERING RESONANCES ON FAST SPECTRA AND DOPPLER COEFFICIENTS. Cohen, S. C.; Russell, J. L. Jr.; Young, J. C. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 579-81(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

5716 MEASUREMENT OF THE EFFECT OF RESONANCE WIDTH ON RESONANCE ABSORPTION OF NEUTRONS. Johnson, B. W. (Lockheed Palo Alto Research Lab., Calif.); Connolly, T. J.; Sher, R. Trans. Amer. Nucl. Soc., 10: 581-2(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

5717 METHOD FOR CALCULATION OF GROUP-AVERAGED RESONANCE PARAMETERS. Nail, J. H. (Battelle-Pacific Northwest Lab., Richland, Wash.); Sheff, J. R.; Robinson, A. H. Trans. Amer. Nucl. Soc., 10: 582-3(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

5718 CONSISTENT VS CONVENTIONAL FEW-GROUP REACTIVITY CALCULATIONS. Greenspan, Ehud (Rensselaer

Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 10: 583-4 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5719 COMPUTER GRAPHICS FOR AUTOMATED NEUTRON CROSS-SECTION EVALUATION. Berland, R. F. (Atomics International, Canoga Park, Calif.); Dunford, C. L.; Creasy, R. J. Trans. Amer. Nucl. Soc., 10: 584 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5720 METHOD FOR CALCULATING SELF-SHIELDING FACTORS FOR MATERIALS CONTAINING CLOSELY SPACED PARTICLES. Ragan, G. L. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 10: 584-5 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5721 DIRECT MEASUREMENT OF ANGULAR COMPONENTS OF THE EPITHERMAL NEUTRON FLUX. Gozani, Tsahi; Trimble, G. D. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 585-6 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5722 INVESTIGATIONS OF SPACE-DEPENDENT VALUES OF Δ-28 IN LIGHT-WATER UO_2 CORES. Osias, David; Cady, K. B. (Cornell Univ., Ithaca, N. Y.). Trans. Amer. Nucl. Soc., 10: 586-7 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

5723 FORMULATION OF NEUTRON DISPERSION RELATIONS IN TERMS OF REACTIVITY. Golay, M. W.; Cady, K. B. (Cornell Univ., Ithaca, N. Y.). Trans. Amer. Nucl. Soc., 10: 588-9 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5724 EFFECT OF AN INTERFACE ON NEUTRON-WAVE PROPAGATION. Baldonado, O. C.; Erdmann, R. C. (Univ. of California, Westwood). Trans. Amer. Nucl. Soc., 10: 589-90 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5725 APPLICATION OF NONLINEAR PROGRAMMING TO CROSS-SECTION ANALYSIS. Stevens, C. A. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 620-1 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5726 PENETRATION OF NEUTRONS IN IRON. Wagschal, J. J. (Columbia Univ., New York); Levine, M. M.; Chernick, J. Trans. Amer. Nucl. Soc., 10: 621-2 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5727 SPATIAL DISTRIBUTIONS IN A ZIRCONIUM-WATER LATTICE OF ACCELERATOR SOURCE NEUTRONS. Stooksberry, R. W. Goldsmith, M. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 622-3 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5728 MEASUREMENT AND ANALYSIS OF DIFFUSION PARAMETERS USING THE HOMOGENEOUS MODERATOR-DETECTOR. McCauley, Edward W.; Albrecht, Robert W. (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 10: 624 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5729 STOCHASTIC MODEL FOR NEUTRON MODERATION CALCULATIONS. Williamson, T. J.; Albrecht, R. W. (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 10: 601-2 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5730 DIRECT MONTE CARLO COMPUTATION OF EXTRAPOLATION LENGTHS. Gelbard, E. M.; Ondis, L. A.; Schmidt, E. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 600 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5731 COMPARISON OF THE WAITING-TIME ALPHA WITH THE ROSSI-ALPHA. Austin, David T.; Zolotar, Burt A.; Cady, K. B. (Cornell Univ., Ithaca, N. Y.). Trans. Amer. Nucl. Soc., 10: 591-2 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5732 AN INVESTIGATION OF THE ROSSI-ALPHA AND PULSED-NEUTRON METHODS FOR MEASURING THE PROMPT-NEUTRON DECAY CONSTANT IN FAST ASSEMBLIES. Murley, T. E. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 10: 592-3 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5733 ANALYSIS OF THE DIE-AWAY OF PROMPT NEUTRONS WITH TWO-GROUP TIME-DEPENDENT SOLUTION OF THE DIFFUSION EQUATIONS IN REFLECTED REACTORS. Karam, R. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 593 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5734 CALCULATION OF THE PROMPT DECAY CONSTANT FOR A REFLECTED ASSEMBLY. Garelis, Edward (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 10: 594 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5735 ANALYSIS OF THE ISOTROPY OF A ^3He SANDWICH NEUTRON SPECTROMETER. Zagotta, W. E.; Semmler, R. A. (Illinois Inst. of Tech., Chicago). Trans. Amer. Nucl. Soc., 10: 616-17 (Nov. 1967).
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5736 AN ACTIVATION DETECTOR WITH A 1/v RESPONSE. Williamson, T. G.; Atwell, R. L. Jr. (Univ. of Virginia, Charlottesville). Trans. Amer. Nucl. Soc., 10: 617-18 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5737 EXTENDED REACTOR SPECTRUM MEASUREMENTS WITH RESPONSE FOILS. Furr, A. Keith; Salaita, N. N. (Virginia Polytechnic Inst., Blacksburg). Trans. Amer. Nucl. Soc., 10: 618 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5738 TIME-OF-FLIGHT MEASUREMENTS OF FAST-NEUTRON SPECTRA IN IRON. Greenspan, Ehud; Malaviya, B. K.; Gaerttner, E. R. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 10: 555-6 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5739 SPATIALLY DEPENDENT RESONANCE NEUTRON SPECTRA IN DEPLETED URANIUM IN SLAB GEOMETRY. Antunez, H. M. (Centro Atomico Bariloche, Argentina); Neill, J. M.; Trimble, G. D.; Beyster, J. R. Trans. Amer. Nucl. Soc., 10: 556-8 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5740 ERBIUM CROSS SECTIONS AND THERMAL SPECTRUM MEASUREMENTS IN AN AQUEOUS SOLUTION OF ERBIUM NITRATE. Gozani, Tsahi; Trimble, G. D. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 558-9 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5741 MEASUREMENT OF THE THERMAL-NEUTRON SPECTRUM IN A SMALL URANIUM ROD. Trimble, G. D.; Gozani, T.; Neill, J. M.; Preskitt, C. A. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 559-60 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5742 THE TEMPERATURE DEPENDENCE OF THE DOPPLER EFFECT IN GOLD. Beller, L. S.; Farrar IV, H. (Atomic International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 560 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5743 ESTIMATES OF DOPPLER COEFFICIENTS FOR IN-CORE THERMIONIC REACTOR MATERIALS. Brehm, Richard

L. (Univ. of Arizona, Tucson). Trans. Amer. Nucl. Soc., 10: 560-2(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5744 MEASUREMENTS OF THE TEMPERATURE COEFFICIENT OF REACTIVITY OF ^{235}U, ^{239}Pu, AND HIGHER Pu ISOTOPES. Springer, T. H.; Tuttle, R. J.; Mountford, L. A. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 562-3(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5745 CORE AND REFLECTOR TEMPERATURE PARAMETRIC EFFECTS ON THE CRITICALITY OF A HIGH-LEAKAGE THERMAL REACTOR. Ibe, L. D.; Gallar, O. H. (Purdue Univ., Lafayette, Ind.). Trans. Amer. Nucl. Soc., 10: 563-4(Nov. 1967).
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5746 TEMPERATURE COEFFICIENTS OF PuO_2–UO_2–H_2O LATTICES. Kobayashi, S. (Hitachi, Ltd., Tokyo); Uotinen, V. O. Trans. Amer. Nucl. Soc., 10: 564-5(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5747 COHERENT ONE-PHONON NEUTRON SCATTERING FROM POLYCRYSTALLINE GRAPHITE. Takahashi, Hiroshi (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 565-6(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5748 NEUTRON THERMALIZATION IN FINITE MEDIA. Dorning, J. (Brookhaven National Lab., Upton, N. Y. Columbia Univ., New York). Trans. Amer. Nucl. Soc., 10: 626-8 (Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5749 PULSED-NEUTRON DECAY CONSTANTS IN CRYSTALLINE MODERATORS. Conn, Robert; Corngold, Noel (California Inst. of Tech., Pasadena). Trans. Amer. Nucl. Soc., 10: 628-9(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5750 SPECTRUM OF THE NEUTRON TRANSPORT OPERATOR IN NONUNIFORM MEDIA. Borysiewicz, M.; Mika, Janusz (Inst. of Nuclear Research, Swierk, Poland). Contract 398/RB. Nukleonik, 10: 203-6(1967).
The time-dependent neutron thermalization in a finite, nonuniform body is studied. An expression for the spectrum of the transport operator is derived, and the solution of the initial value problem is shown to exist. (auth)

5751 NEUTRON FLUXES IN CONCRETE DUCTS ARISING FROM INCIDENT EPICADMIUM NEUTRONS: CALCULATIONS AND EXPERIMENTS. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 30: 340-54(1967).
Monte Carlo calculations, using the albedo concept, were carried out to determine subcadmium and epicadmium neutron flux distributions along the centerline of a straight, a two-legged, and a three-legged square concrete duct arising from the slowing down of incident epicadmium neutrons for a particularly demanding source geometry and spectrum. The calculations used albedo data differential both in the reflected angles and reflected energy which have been reported previously for concrete. A comparison of the results of these calculations with those from a geometrically similar experiment shows good agreement and places on a firm foundation the concept of treating neutron slowing down in a concrete duct as a reflection phenomenon at a point which is describable by the differential albedo properties of the walls. The conclusion is also reached that the dose rates arising from the subcadmium neutrons (whether due to an epicadmium source or a subcadmium source) and associated secondary wall-capture gamma rays can comprise a very important part of the total absorbed dose rate in tissue deep inside a multilegged duct. (auth)

5752 PRODUCTION OF MONOENERGETIC NEUTRONS USING PARTICLE ACCELERATORS. Coppola, M.; Knitter, H.-H. (EURATOM, Geel, Belg.). Kerntechnik, 9: 459-70 (Oct. 1967).
The selection of appropriate reactions and targets for the production of neutron beams of desired energies and intensities is discussed. The reactions $^{9}Be(\alpha,n)^{12}C$, $D(d,n)^{3}He$, $^{7}Li(p,n)^{7}Be$, $T(d,n)^{4}He$, and $T(p,n)^{3}He$ are considered in detail. Information on the cross sections of these reactions and on the neutron energies provided is presented as functions of incident particle energy. Information on the stopping powers of the most widely used target materials is also included. (D.C.W.)

5753 NEW INTERPRETATION OF PULSED NEUTRON EXPERIMENTS IN A REFLECTED REACTOR. Waltar, Alan Edward. Berkeley, Calif., Univ. of California, 1966. 140p.
Thesis.
A new interpretation of pulsed-neutron reactivity measurements in reflected reactors was developed and tested. The theory employs the Cohn model to describe the system, and provides an expression for reactivity which may be evaluated either in terms of core data or reflector data. Solving the system equations for a delta-function source results in an expression for the neutron density in either core or reflector. The reactivity, which is defined in a way somewhat different from that of Cohn, can be evaluated directly in terms of experimentally obtained parameters. The expression for reactivity consists of two terms corresponding to the two characteristic prompt modes of the system. One is identical to that originally derived by Gozani, and the other arises as the direct result of including the reflector in the analysis. The treatment is extended to include neutron bursts of finite width, and corrections are made to allow for dead time loss in the multichannel analyzer used to record the time decay of the neutron density. Although the theory was originally developed for one equivalent delayed-neutron group, analysis shows that the reactivity determination is unaffected by the number of groups considered. Also, expressions are derived which allow the coupling coefficients inherent in the Cohn model to be determined from experimental data. Experiments performed on the AGN-201 reactor were made to test the theory and rather conclusive verification was obtained. In all cases below about one dollar subcritical, the reactivity as evaluated by only the Gozani term from core data was substantially smaller in magnitude than the evaluation using reflector data. For the same runs, an evaluation by both terms as required by the new theory resulted in a constant value, independent of detector position within the experimental errors given. Similar results were obtained by leaving the core and reflector detectors fixed and moving the source. Also, in support of the theory, the ratio of the prompt mode intercepts was experimentally determined to be positive in the core and minus unity in the reflector. Although the new technique appears valid for the reactor system upon which it was tested, the full range of validity is not yet known. Discussions concerning the applicability of the Cohn model to other systems are included. (Disser. Abstr.)

5754 NEUTRON SOURCE. Acree, Elick H.; Tatum, William G. (to U. S. Atomic Energy Commission). U. S. Patent 3,360,477. Dec. 26, 1967.
A neutron source of the alpha-neutron reaction type comprising a mixture of a first parent element selected from the group consisting of ^{241}Am and ^{237}Np; a target metal selected from the group consisting of B and Be; and a second element selected from the group consisting of ^{242}Cm and ^{238}Pu; which is produced in situ by neutron irradiation for a period of time sufficient to convert at least 21% of the first element to the second element, is described. (TSN)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 4938, 5140, 5577, 5769, 5901, and 5902.

5755 (TID-24141) ABSORPTION OF S-ORBIT π^- MESONS BY ^{4}He. Koltun, Daniel S.; Reitan, Arne (Norges Tekniske Hoegskole, Trondheim (Norway). Institutt for Teoretisk Fysikk). [1967]. 29p. Dep. CFSTI.
Also published as Arkiv for det Fysiske Seminar i Trondheium, No. 11, 1967.
The rate for absorption of s-orbit bound π^- mesons by correlated nucleon pairs, and the distributions in momentum and laboratory angle of the emitted fast nn or np pair, are calculated for ^{4}He. The pion is assumed to be absorbed either directly by one nucleon, or by processes that involve exchange of the absorbed pion between the two nucleons in question. The absorbing nucleon pair is assumed to interact in the initial state through a harmonic-oscillator potential plus a short-range (Hamada-Johnston) interaction, and in the final state only through the short-range interaction. (auth)

5756 EFFECTS OF THE COULOMB REPULSION ON THE ELECTRO-MAGNETIC RADII OF ^{3}H AND ^{3}He NUCLEI. Ohmura, Takashi (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 38: 626-35(Sept. 1967).

The triton and ^{3}He wave functions are identical if the nuclear forces are charge symmetric and the Coulomb force between two protons in the ^{3}He nucleus is absent. The Coulomb potential between two protons induces the expansion and the distortion of the ^{3}He nucleus. The effects due to the expansion and the distortion on the electromagnetic form factors of the three-body nuclei are discussed. It is shown that the actual expansion is considerably smaller than that estimated from the binding energies of both nuclei. The distortion is proportional to the induced amplitude of the $T = {}^3/_2$ state and is found to be very small. The effects due to this Coulomb repulsion alone are not sufficient to account for the observed differences in the electromagnetic form factors. The $T = {}^3/_2$ state probability in the ^{3}He nucleus is estimated to be 0.001 ~ 0.006%. (auth)

5757 THE NUCLEAR PHOTOEFFECT IN ^{3}H. Pfeiffer, R. (Univ., Heidelberg). Z. Phys., 208: 129-41(1968). (In German).

The nuclear photoeffect in tritium was investigated by irradiating a gaseous ^{3}H target with bremsstrahlung of 32.5-MeV endpoint energy in the collimated beam of the Heidelberg betatron. Protons and deuterons from the reactions ^{3}H(γ,n)d and ^{3}H(γ,p)2n were measured independently at 90 ± 15° with respect to the γ beam by a dE/dx – E semiconductor telescope. The cross section of the two-body disintegration ^{3}H(γ,n)d is derived for γ energies from 18 to 31 MeV. The integrated cross section from threshold to 32 MeV is 11.8 ± 1.4 MeV mb. The cross section of the three-body disintegration ^{3}H(γ,2n)p is obtained by making assumptions regarding the angular distribution and energy division among the three disintegration products, which appear plausible on theoretical grounds. Within experimental errors the results reported seem to be in agreement with a theoretical calculation by Fetisov. (auth)

5758 BINDING ENERGY OF TRITON AND n-d SCATTERING LENGTHS WITH SEPARABLE POTENTIALS. Kharchenko, V. F.; Petrov, N. M.; Storozhenko, S. A. (Inst. of Physics, Kiev). Nucl. Phys., A196: 464-75(1967).

On assumption that the interaction between nucleons is described by a non-local, separable potential, the triton binding energy as well as the neutron–deuteron scattering lengths are calculated with various forms of the two-particle potential. The potential parameters were determined from the data on the interaction of two nucleons at low energies. The binding energy and doublet length have been studied as functions of the singlet effective range of the interaction between nucleons. Unlike the quartet length, the binding energy and doublet length are found to depend essentially on the shape of the two-particle potential. The allowance for the tensor forces results in a closer agreement with the experimental data. In the case of the certain separable potential involving the tensor interaction and describing the interaction between nucleons at low energies, it has been found that the triton binding energy and doublet scattering lengths are in agreement with experimental values. (auth)

5759 π^--HELIUM INELASTIC INTERACTIONS AT 140 MeV. Kaufman, L.; Gauld, B. W.; Perez-Mendez, V.; Sperinde, J. M.; Williams, S. H. (Univ. of California, Berkeley). Phys. Lett., 25B: 536-7(Nov. 13, 1967). (UCRL-17846).

Excited and multineutron final states were studied in the reaction $\pi^- + {}^4$He. An excited state of helium is detected at 32 ± 1 MeV. Upper limits on the existence of bound trineutrons and tetraneutrons are established. Large distortions from phase-space predictions are observed in the 3n spectrum. (auth)

5760 PROTON–DEUTRON INELASTIC SCATTERING. Dubovoi, E. I. Yadern. Fiz., 6: 753-60(Oct. 1967). (In Russian).

New experimental results from the reaction d(p,n)2p at an incident proton energy of 9 MeV are theoretically interpreted. On the basis of qualitative properties of the behavior of the differential cross section $\partial\sigma/\partial E_1 \partial\Omega_1 \partial\Omega_2$ as a function of kinematic variables, the reaction mechanism is identified. (auth)

5761 THE INTERACTION OF 14.1 MeV NEUTRONS WITH TRITONS. Kootsey, Joseph Mailen. Providence, Brown Univ., 1966. 95p.

Thesis.

A thin tritium target was bombarded by 14.1-MeV neutrons and the outgoing protons, deuterons, and tritons studied with a specially designed and constructed counter telescope and electronics system. The double proportional counter-scintillator telescope featured special provisions for eliminating effects from the natural tritium beta particles and, with the associated electronics, was able to distinguish between protons, deuterons, and tritons in the energy range between 0.5 and 14 MeV. The light response of CsI(Tl) to tritons from 0.5 to 10 MeV was shown to be linear. An angular distribution for n-T elastic scattering was obtained for neutron angles of 55° to 180° in the cm system. This distribution was compared with previous resonating group structure calculations of elastic scattering for the purpose of comparing the relative merits of the Serber and symmetric exchange mixtures and the inclusion of other force types. The best fit was provided by the Serber mixture with the possible inclusion of some spin-orbit forces. Deuterons from the breakup reaction T(n,d)2n were detected at $\theta_{lab} = 0°$ and the spectrum fitted by the final state interaction system. Because of a high proton background, no charged particles from T(n,p)3n were observed. (Disser. Abstr.)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 4183, 4500, 5498, 5577, 5600, 5798, 5806, 5809, 5830, 5831, 5854, 5873, 5887, 5888, and 5896.

5762 (JINR-P6-3463) ISSLEDOVANIE γ IZ LUCHENIYA IZ REAKTSII ^{12}C(^{3}He,pγ)^{14}N. (Studies of γ Emission from ^{12}C(^{3}He,pγ)^{14}N Reaction). Mareev, Yu. D.; Osetinskii, G. M.; Savitska, B.; Sizov, I. V.; Yazvitskii, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1967. 15p. (In Russian). Dep.

Using an electrostatic generator, the γ emission from the reaction ^{12}C(^{3}He,pγ)^{14}N was investigated. By use of the Doppler broadening of the spectral peaks, the upper limits of the lifetimes of the six observed levels of ^{14}N were determined to be $\leq 5 \times 10^{-13}$ sec. On the basis of the angular distribution of the γ quanta, the spins for some excited states of the nuclei ^{13}O and ^{14}N were evaluated. (tr-auth)

5763 (ORNL–4183) GAMMA RAYS FROM BOMBARDMENT OF ^{7}Li, Be, ^{11}B, C, O, Mg, Al, Co, Fe, AND Bi BY 16- TO 160-MeV PROTONS AND 59-MeV ALPHA PARTICLES. Zobel, W.; Maienschein, F. C.; Todd, J. H.; Chapman, G. T. (Oak Ridge National Lab., Tenn.). Nov. 1967. Contract W-7405-eng-26. 71p. Dep. CFSTI.

Determining the contribution of secondary gamma rays to the radiation dose produced by charged particles in space requires a knowledge of the cross sections for gamma-ray production by protons and alpha particles. The only data of this type that has been available has been for ~145-MeV protons. In the experiment reported, gamma-ray spectral measurements were made for protons of 16, 33, 56, and 160 MeV and alpha particles of 59 MeV incident on targets of low- and medium-Z materials. Absolute spectra were obtained, generally in the backward direction, with coincidence (pair) or anticoincidence (total-absorption) scintillation spectrometers. The analysis method used to correct for the imperfect spectrometer response yielded quantitative error estimates for the spectra. A few measurements were made in the forward direction or at 90° to distinguish deviations from isotropy which were marked only for 16-MeV protons incident on a carbon target. From the spectra, cross sections were obtained for the production of specific gamma rays. Tables of these results include the probable nuclear reactions which produced the gamma rays. The production cross sections are plotted versus the average proton energy in the target for individual gamma rays for C and O, and their sums, which decrease with increasing proton energy, are compared with the total nonelastic cross sections predicted on the basis of intranuclear cascade calculations. The reasonably smooth variations of the total cross sections for gamma-ray production with atomic number are also shown. Finally, the gross gamma-ray production by protons is found to be roughly proportional to the stopping power, the proton inelastic scattering cross sections for specific levels correspond within error to 14-MeV neutron scattering data, and the gamma-ray spectra observed for 160-MeV incident protons are compared with calculated spectra. (auth)

5764 A SIMPLE MODEL OF ^{9}Be AND THE REACTION ^{9}Be(γ,n)^{8}Be. Boffi, S. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy); Pacati, F. D.; Sawicki, J. Nuovo Cim. (10), 52B: 244-7(Nov. 11, 1967).

A model for odd-A nuclei in which the single-particle states of the valence nucleon are vector-coupled to the rotational core excitation was applied to the nucleus ^{9}Be. The model was also used to calculate the differential and total cross sections for the ^{9}Be(γ,n) ^{8}Be reaction as well as the transverse spin polarization of the photoneutron from the reaction. (D.C.W.)

5765 NEUTRON-PROTON CORRELATIONS IN THE REACTION ^{12}C(d,np)^{12}C. Bohne, W.; Hilscher, D.; Homeyer, H.; Morgenstern, H.; Scheer, J. A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys., A106: 442-8(1967).

In the reaction ^{12}C(d,np)^{12}C, angular and energy correlations

between neutrons and protons were measured for neutron emission angles of 12.5, 40, 70, and 90° at deuteron energies of 5.4 and 6.0 MeV. Sequential and nonsequential reaction modes and proximity scattering were observed and were discussed. (auth)

5766 (p,d) REACTIONS ON LIGHT NUCLEI AT 100 MeV. Lee, J. K. P.; Mark, S. K.; Portner, P. M.; Moore, R. B. (McGill Univ., Montreal). Nucl. Phys., A106: 357-68(1967).

A number of light nuclei were studied via single-neutron pick-up reactions induced by 100-MeV protons. The elements studied were ^{7}Li, ^{9}Be, ^{12}C, and ^{16}O. Deuteron groups resulting from the excitation of low-lying states of the residual nuclei were measured over an angular range from 5 to 80° (lab). Differences in the angular distributions for $1p_{\frac{1}{2}}$ and $1p_{\frac{3}{2}}$ shell neutron pick-up indicate a spin dependence in the interaction. All deuteron groups exhibited abnormally large differential cross sections at angles as large as 80°. The results obtained are discussed within the framework of various nuclear models. (auth)

5767 ENERGY LEVELS IN ^{6}Li AND ^{7}Li FROM INELASTIC PROTON SCATTERING. Mani, G. S.; Dix, A. D. B. (Univ. of Manchester, Eng.). Nucl. Phys., A196: 251-60(1967).

The energy levels in ^{6}Li and ^{7}Li were obtained up to an excitation energy of 17 MeV from inelastic scattering of 50-MeV protons by isotopically enriched targets of lithium isotopes. The level structure observed in mass-6 and -7 nuclei are discussed in terms of various models. (auth)

5768 CALCULATION OF ^{16}O BINDING ENERGY. II. Kohler, H. S.; McCarthy, R. J. (Rice Univ., Houston, Tex.). Nucl. Phys., A106: 313-22(1967).

Improvements were made in previous calculations of the binding energy of ^{16}O. The integral equation relating the exact reaction matrix to the one neglecting the Pauli principle, previously solved by a perturbation method, is now solved exactly. Correlation (rearrangement) corrections to single-particle energies are calculated for the Hamada–Johnston potential. The energy diagrams with these corrections inserted in hole lines are also calculated and give ≈0.3 MeV binding/nucleon. The single-particle excitation diagrams are found to give ≈0.1 MeV binding/nucleon. Kinetic energies only are used in intermediate states when defining the reaction matrix. Including also harmonic oscillator potential energies decreases the binding by ≈0.65 MeV/nucleon. Including all corrections calculated to date, the Hamada–Johnston potential gives 3.7 MeV/nucleon for ^{16}O. Improvement of the shell-model potential might increase this binding slightly, but there is a definite discrepancy with the experimental binding 7.98 MeV/nucleon. The result is qualitatively in agreement with nuclear-matter calculations. Unless further diagrams contribute significantly (or basic errors in the theory exist), it is evident that a different nucleon potential, e.g., a soft core, is needed. (auth)

5769 LIFETIME AND ENERGY OF THE GROUND STATE OF ^{8}Be. Benn, J.; Dally, E. B.; Mueller, H. H.; Pixley, R. E.; Staub, H. H.; Winkler, H. (Univ., Zurich). Nucl. Phys., A196: 296-312(1967).

A detailed account of measurements of the ground-state energy and the lifetime of ^{8}Be by $\alpha-\alpha$ elastic scattering is presented. The nuclear ground-state energy is $E_0 = 92.12 \pm 0.05$ keV; the width of the ground state $\Gamma = 6.8 \pm 1.7$ eV corresponds to a lifetime $\tau = 0.97 \times 10^{-16}$ sec. (auth)

5770 STATES IN ^{12}C AND ^{16}O INVESTIGATED BY THE ^{11}B(d,n) AND ^{15}N(d,n) REACTIONS. Fuchs, H.; Grabisch, K.; Kraaz, P.; Roeschert, G. (Hahn-Meitner Institut fuer Kernforschung, Berlin. Sektor Kernphysik, Berlin). Nucl. Phys., A105: 590-600(1967).

Neutrons from the 6 MeV deuteron bombardment of ^{11}B and ^{15}N were investigated by the time-of-flight method. Angular distributions of (d,n) transitions to nine states in ^{12}C up to 16.11 MeV and to five states in ^{16}O up to 8.88 MeV excitation energy were obtained and analyzed with DWBA theory to yield l-values and spectroscopic factors. The results are reasonably well interpreted in the framework of the shell model by ascribing a predominant one-particle–one-hole component to most of the observed excited states. Prominent exceptions are the 0^+(7.66 MeV) state in ^{12}C and the 2^+(6.92 MeV) state in ^{16}O for which a more complicated structure is required. (auth)

5771 THREE-BODY BREAK-UP IN THE REACTION ^{7}Li (d,n)$\alpha\alpha$. Jeremie, H.; Martin, Ph.; Calamand, A. (Univ., Montreal). Nucl. Phys., A105: 689-97(1967).

The energy spectra of alpha particles in coincidence with neutrons were studied in the reaction ^{7}Li(d,n)2α at a deuteron energy of 180 keV. The form of the spectra can be roughly approximated by a spectral form $\rho(E) = (d/dE)(\delta + \Phi)$ proposed by Phillips, Griffy and Biedenharn for sequential decay. A major discrepancy between sequential decay prediction and experiment exists in the α-n angular correlation corresponding to the $P_{\frac{3}{2}}$ first excited state of ^{5}He. (auth)

5772 COUPLED CHANNEL ANALYSIS IN PROTON SCATTERING FROM ^{19}F. Thompson, W. J. (Florida State Univ., Tallahassee); Edwards, Steve; Tamura, Taro. Nucl. Phys., A105: 678-88(1967). (ORNL-P-3271).

Elastic and inelastic differential cross sections measured for protons of incident energies 4.26, 5.96, and 6.87 MeV scattered from ^{19}F are analyzed using the adiabatic coupled channel (ACC) approximation. The scattering to the first two, positive-parity states ($\frac{1}{2}^+$ and $\frac{5}{2}^+$) of the ground state rotational band are considered, the excitation of negative-parity states being negligibly weak. Using a quadrupole deformation $\beta = 0.37$ determined from Coulomb excitation measurements, good fits to the $\frac{1}{2}^+$ and $\frac{5}{2}^+$ state differential cross sections are obtained by varying only the surface absorption potential with energy, all other parameters being fixed. Comparison with a spherical, optical-model analysis of the same data shows that the latter model overestimates the spin-orbit potential by a factor of 3 compared with the value obtained from the ACC analysis. The effect is related to the large deformation. (auth)

5773 POLARIZATION OF 15.85-MeV NEUTRONS SCATTERED BY CARBON. Mack, G.; Mertens, G. (Univ., Tuebingen, Ger.). Z. Naturforsch., 22a: 1640-1(Oct. 1967).

Asymmetries for the elastic and inelastic scattering of polarized 15.85-MeV neutrons on ^{12}C were measured, and polarization angular distributions were obtained. (D.C.W.)

5774 OBSERVATION OF THE REACTION ^{18}O(p,n)^{18}F INITIATED BY PROTONS IN WATER IRRADIATED IN A LINEAR ACCELERATOR. Wilkniss, Peter E. (Naval Research Lab., Washington, D. C.). Int. J. Appl. Radiat. Isotop., 18: 809-13 (Dec. 1967).

Triply distilled water was irradiated in a bremsstrahlung beam at 23- and 30-MeV maximum energy. ^{18}F was detected in the samples irradiated at 30 MeV, but no ^{18}F was observed at 23 MeV. It was concluded that the most likely source of the ^{18}F is the reaction ^{18}O(p,n)^{18}F with the initiating protons coming from the reaction ^{16}O(γ,p)^{15}N. (auth) (UK)

5775 EXCITATION OF 15.11-MeV LEVELS IN ^{12}C AND ^{13}C BY INELASTIC ELECTRON SCATTERING. Peterson, G. A. (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Lett., 25B: 549-50(Nov. 13, 1967). (YALE-2726-502).

The M1 radiation widths to the ground states of the 15.11 MeV levels in ^{12}C and ^{13}C were determined to be 36 ± 3 eV and 25 ± 7 eV, respectively, by the inelastic scattering of 40- to 65-MeV electrons from a solid target enriched to 58% in ^{13}C and a comparison ^{12}C target. These results are in agreement with the shell-model predictions of Cohen and Kurath. (auth)

5776 THE 27.6-MeV STATE IN ^{16}O. Weller, H. R. (Duke Univ., Durham, N. C.); Roberson, N. R.; Tilley, D. R. Phys. Lett., 25B: 541-2(Nov. 13, 1967).

The reaction ^{13}C(^{3}He,α)^{12}C was investigated in the E(^{3}He) = 5.1 to 8.4-MeV region. Differential cross sections for the three highest-energy α-particle groups were measured in 100-keV intervals. The results are dominated by a $J^\pi = 3^-$, T = 0, resonance corresponding to a state in ^{16}O at $E_x = 27.6$ MeV. This state has been predicted from the eigenchannel reaction theory in the 1p-1h approximation. (auth)

5777 ELASTIC SCATTERING OF ^{16}O, ^{17}O, AND ^{18}O ON ^{12}C AND THE SPATIAL EXTENSION OF THE OXYGEN ISOTOPES. Goldring, G.; Loebenstein, H. M.; Plesser, I.; Sachs, M. W. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Lett., 25B: 538-40(Nov. 13, 1967).

The elastic scattering of ^{16}O, ^{17}O, and ^{18}O from ^{12}C was measured at $E_{lab} = 35.0$ MeV. The differences in the angular distributions are interpreted as differences in the relative boundary diffuseness. The radius parameter r_0 is essentially the same for the three isotopes. (auth)

5778 NUCLEAR RADII OF LIGHT NUCLEI FROM MUONIC X-RAY MEASUREMENTS. Backenstoss, G.; Charalambus, S.; Daniel, H.; Koch, H.; Poelz, G.; Schmitt, H.; Tauscher, L. (CERN, Geneva. Max-Planck-Institut fuer Kernphysik, Heidelberg. Univ., Karlsruhe, Ger.). Phys. Lett., 25B: 547-9(Nov. 13, 1967).

Measurements of the muonic 2p-1s transition energies in nuclei with $Z \leq 17$ are reported. Nuclear charge radii are deduced and are compared with data from electron scattering. (auth)

5779 THE g_I FACTORS AND THE MAGNETIC MOMENTS OF ALKALI NUCLEI AND THE SHIELDING OF Rb^+ BY WATER. Lutz, O. (Univ., Tuebingen, Ger.). Phys. Lett., 25A: 440-1 (Sept. 25, 1967).

The ratios of the g_I factors of ^{6}Li, ^{7}Li, ^{23}Na, ^{87}Rb, and ^{133}Cs to ^{2}D were measured by the NMR method in solutions of alkali salts in D_2O. The shielding of Rb^+ by water is evaluated and is compared with theory. (auth)

5780 MONOPOLE EXCITATION OF THE 0^+ STATE AT 6.056 MeV IN ^{16}O. Bishop, G. R. (Glasgow Univ.). Phys. Lett., 25B: 499-500(Oct. 30, 1967).

New and old data on the excitation of the levels at 6.056 MeV (0^+) and 6.135 MeV (3^-) in ^{16}O by electron scattering are put together and analyzed into separate form factors for the two transitions. Comparison of the experimental monopole form factor with calculations using deformed basis functions shows disagreement both as to magnitude and functional dependence on the momentum transfer. (auth)

5781 A STUDY OF CROSS SECTION FLUCTUATIONS FOR ^{6}Li BOMBARDMENT OF ^{12}C. Dzubay, Thomas Gary. Minneapolis, Univ. of Minnesota, 1966. 68p.

Thesis.

Differential cross sections for ^{6}Li + ^{12}C reactions were measured in 100 keV steps between 2.4 and 8.5 MeV at 0° and in 200 keV steps between 3.4 and 7.4 MeV at 40° (LAB). Fluctuations in the cross sections are observed at all energies, but they are superimposed upon a rapid rise in cross section for beam energies below 5 MeV due to the Coulomb barrier effects. Coulomb barrier effects are accounted for by calculating the average differential cross section from the Hauser–Feshbach formula in which the transmission coefficients are calculated from an optical model potential. The ratios of the observed to calculated cross sections fluctuate about an average that is nearly constant. These ratios are analyzed in terms of the Ericson fluctuation theory from which the coherence width Γ and the direct reaction contribution Y_d are estimated to be Γ = 220 keV (CM) and Y_d = 0 to 50%. The average cross section ratio for the ^{6}Li(^{12}C,α_1)^{14}N reaction indicates a 30% violation of isobaric spin conservation. (Disser. Abstr.)

5782 EVEN PARITY ROTATIONAL BANDS IN ^{16}O. Celenza, Louis Silvio. Philadelphia, Univ. of Pennsylvania, 1966. 125p.

Thesis.

Experimental information regarding the positions of energy levels and the transition rates between certain of these levels indicates that rotational motion may be important in the microscopic description of ^{16}O. In particular the low-lying even parity levels of ^{16}O may be qualitatively described as consisting of two even parity rotational bands which are allowed to interact with one another. No detailed microscopic calculation has as yet verified this qualitative description. This thesis provides such a calculation. The method of calculation consists of two parts. In the first part variational techniques are employed to find the intrinsic wave functions which generate the two even parity bands. The treatment of the intrinsic wave function of the first even parity band is similar to that provided by other authors. The generating wave function for the second even parity band, however, has been found using a new procedure. This procedure allows the intrinsic wave function of the second even parity band to be isolated in energy from other competing wave functions. The second part of the calculation includes a projection of states of good angular momentum from the intrinsic wave functions. These states may be grouped into two bands. The bands are then mixed utilizing a residual interaction. These mixed wave functions enable calculation of the electric quadrupole transition rates of interest in ^{16}O. The bulk of the results consists of the prediction of the positions of various low-lying even parity levels in ^{16}O and the transition rates between certain of these levels. These results are compared with the experimental values and those of other authors. Agreement with experiment is satisfactory. Most of the calculated energy levels are within 10% of the experimental values while the transition rates are of the right order of magnitude. The electric monopole transition matrix element is also computed and compared to the experimental value and those of other authors. (Disser. Abstr.)

5783 A STUDY OF THE ^{13}C(^{3}He,d)^{14}N REACTIONS. Bastawros, Abdelmalak Mesak. Rochester, N. Y., Univ. of Rochester, New York, 1967. 88p.

Thesis.

The mechanism of the ^{13}C(^{3}He,d) reaction was studied to investigate the structure of ^{14}N low-lying levels. 80 absolute cross sections for deutron groups leading to the first five low-lying states of ^{14}N were measured. To examine variation of cross section with energy, an excitation function was measured. Elastic scattering of ^{3}He from ^{12}C was also measured. The measurements were performed using a counter telescope system for particle identification. The observed cross sections were analyzed using distorted wave Born approximation formalism. Satisfactory agreement was found assuming that simple stripping is the dominant mechanism. An l_p = 1 capture was observed corresponding to transitions to the ground state, first and second excited state, and l_p = 0 for the 3rd excited state and an l_p = 2 for the 4th excited state. From the analysis of the extracted spectroscopic factors it was found that intermediate coupling calculations for ^{14}N 1p shell levels should include a tensor term in the two-body interaction. In addition admixing of higher configurations seems to be present. (Disser. Abstr.)

5784 THE ^{16}O(^{3}He,n)^{18}Ne DOUBLE STRIPPING REACTION. Krick, Merlyn Stewart. Philadelphia, Univ. of Pennsylvania, 1966. 158p.

Thesis.

An 11 MeV ^{3}He beam from the University of Pennsylvania's tandem Van de Graaff accelerator was used for the study of the ^{16}O(^{3}He,n)^{18}Ne reaction. The neutrons were detected with a double scatter time-of-flight spectrometer. The target was a cell of oxygen gas. Neutrons were measured for the ground and first excited state transitions at eight laboratory angles from six to fifty degrees. The resulting angular distributions were analyzed with Newns' plane wave double stripping theory. The ground state transition was well fitted with L = 0, implying 0^+ for the ^{18}Ne ground state; the first excited state transition was well fitted with L = 2, implying 2^+ for the 1.88 MeV level of ^{18}Ne. The peak cross sections in the angular distributions were found to be 21 ± 4 mb/sr for the ground state and 11 ± 2 mb/sr for the first excited state. These results are compared with predictions of the diffraction model and distorted wave theories of Henley and Yu; low energy ^{16}O(^{3}He,n)^{18}Ne ground state angular distribution data; and absolute cross sections and angular distributions for the mirror reaction ^{18}O(t,p)^{18}O. (Disser. Abstr.)

5785 PHOTOPRODUCTION OF WIDE ANGLE ELECTRON PAIRS FROM CARBON. Sinclair, Charles Kent. Ithaca, N. Y., Cornell Univ., 1967. 121p.

Thesis.

The cross section for the photoproduction of high energy electron positron pairs from carbon at large angles to the incident photon was measured using a magnet and spark chamber system in conjunction with the Cornell 2.2 GeV electron synchrotron. Both members of the pair were detected in a symmetric arrangement which maintained constant geometry and a fixed ratio between the peak photon energy and the momenta of each member of the pair. The pion pair background was eliminated by observing the build up of showers from the pair members in a heavy plate spark chamber. Peak photon energies ranged from 600 MeV to 2000 MeV, corresponding to electron positron pair effective masses of 47 MeV to 202 MeV at the mean angles employed. The results show an excess of high effective mass pairs over what is expected from the Bethe–Heitler formula. This result is consistent with a similar discrepancy found by a group at the Cambridge Electron Accelerator. Taken by itself, the measurement shows a 2.3 standard deviation difference from the Bethe–Heitler formula. (Disser. Abstr.)

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Refer also to abstracts 5763, 5778, 5779, 5809, 5817, 5830, 5831, 5843, 5851, 5854, 5867, 5874, 5884, 5887, and 5897.

5786 (JINR-P3-3456) NEITRONNYE POPERECHNYE SECHENIYA I SILOVYE FUNKTSII IZOTOPOR GERMANIYA. (Neutron Cross Sections and the Force Function of Germanium Isotopes). Maletski, Kh.; Pikel'ner, L. B.; Salamatin, I. M.; Sharapov, E. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1967. 14p. (In Russian). Dep.

The passage, self-indication, and radiative capture of neutrons in separated isotopes of Ge were investigated using the pulsed IBR reactor with a microtron. The parameters of the levels in the range up to 30 keV for even isotopes and up to 9 keV for odd isotopes were obtained. For two isotopes, the values of the strength functions, the mean distances between levels, and the mean radiation widths were found. (tr-auth)

5787 (NIJS-R-505) GAMMA-RAY SPECTRA FROM THE RADIATIVE CAPTURE OF 14 MeV NEUTRONS BY ^{28}Si AND ^{40}Ca. Cvelbar, F.; Hudoklin, A.; Mihailovic, M V. (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). July 1967. 6p. Dep.

The spectra of gamma rays from the radiative capture of 14.1-MeV neutrons by ^{28}Si and ^{40}Ca, as measured by a telescopic scintillation pair spectrometer, are presented. The spectrum for ^{28}Si is found to be similar to that of ^{27}Al. This fact supports a previous

statement that the spectra for nuclei having the same configuration of neutrons exibit a similar structure due to the preferred transitions to the single-particle neutron states. The spectrum of gamma rays from the neutron capture by ^{40}Ca is fairly flat and has a rather well pronounced low-energy limit due to the absence of gamma rays from the (n,n',γ) processes at gamma-ray energies higher than 11 MeV. (auth)

5788 (NP-17149) THE ^{52}Cr(p,γ)^{53}Mn REACTION. Vuister, Petrus Hendrikus (Utrecht Rijksuniversiteit (Netherlands)). 1966. 63p. Dep.

The reaction ^{52}Cr(p,γ)^{53}Mn was investigated in the energy region E_p = 1.36 to 2.26 MeV. The resonance energies, the corresponding ^{53}Mn excitation energies, and the resonance strengths of 199 resonances, assigned to this reaction, are reported. The excitation energies and gamma-ray branchings of 13 bound states were determined from the measurement of single and coincidence gamma-ray spectra at 20 resonances. The excitation energies are in excellent agreement with values recently obtained with the ^{56}Fe(p,α)^{53}Mn reaction. (auth)

5789 (SC-DC-67-2032) TWO-NEUTRON CONFIGURATIONS IN THE EVEN CALCIUM ISOTOPES AS OBSERVED IN THE (t,p) REACTION. Williams, David C. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 12p. (CONF-671040-3). Dep. CFSTI.

From Meeting of the Division of Nuclear Physics, Madison, Wis.

Recent data on the reactions ^{40,44,46,48}Ca(t,p) are summarized. The strong transitions may be interpreted without assuming heavy mixing of the various two-neutron configurations that are the principal contributors to the (t,p) reaction amplitude, though these configurations evidently do mix with configurations involving core excitation. Thus, the strong transitions of a given L value are grouped in such a way that each group may be assigned to one of the expected two-neutron configurations having the appropriate J^π. The interpretation offered indicates that the configurations $[(f_{7/2}^{-2})_{J=0}\, f_{5/2}\, p_{3/2}]$ and $[(f_{7/2}^{-2})_{J=0}\, p_{3/2}^2]$ constitute at most minor components of states below 4.4 MeV in ^{42,46}Ca; recent ^{43}Ca(d,p) data indicate that the same is true of ^{44}Ca. States of the (20/20) core are important. This description differs from treatments of these isotopes which emphasize mixtures of the various $1f_{7/2} - 2p_{3/2}$ neutron configurations and consider states of the (20/20) core only secondarily, if at all. (auth)

5790 (CEA-tr-A-1898) SEPARATION DE ^{32}P, ^{33}P, ET ^{35}S PAR LA METHODE D'ABSORPTION β. (Separation of ^{32}P, ^{33}P, and ^{35}S by the β Absorption Method). Kohler, W.; Knopf, K. (Technische Hochschule, Munich (West Germany)). Translated into French from report FRM-65. 28p. (In French). Dep. CFSTI. JCL $2.60 fs, $1.07 mf.

A measurement bank for recording β absorption curves was constructed in order to study β emitters. The percentages of the contents of ^{32}P, ^{33}P, and ^{35}S in irradiated sulfate solutions, determined by the absorption method, do not agree with the values of ^{33}P and ^{35}S calculated from the cross sections and the flux density. For this reason a determination was made of the effective cross section of the reaction ^{33}S(n,p)^{32}P. For the density distribution of the existing flux, the mean cross section $^{33}P_{[\sigma]}$ = 0.38 ± 0.02 was obtained with respect to $^{32}P_{[\sigma]}$ = 66mb for the reaction ^{32}S(n,p)^{32}P. (tr-auth)

5791 MOESSBAUER SPECTROSCOPY OF THE 29.4 keV GAMMA RAY OF ^{40}K FROM THE REACTION ^{39}K(n,γ)^{40}K. Hafemeister, D. W. (Carnegie Inst. of Tech., Pittsburgh. Los Alamos Scientific Lab., N. Mex.); Shera, E. Brooks. Contract W-7405-eng-36. pp 231-41 of Moessbauer Effect Methodology. Gruvermann, Irwin J. (ed.). New York, Plenum Press, 1967. (LA-DC-8588).

From 3rd Annual Moessbauer Symposium, New York, Jan. 29, 1967. See CONF-670110-(Vol.3).

Because the levels of ^{40}K are not populated by beta decay, it is necessary to use a nuclear reaction to produce the 29.4-keV ground-state transition in ^{40}K. By passing a beam of thermal neutrons through the cryostat containing source and absorber, it has been possible to utilize the ^{39}K(n,γ)^{40}K reaction for the Moessbauer spectroscopy of ^{40}K. A thermal neutron beam does not cause target heating and the (n,γ) reaction method can be used for low temperature Moessbauer studies of both insulators and metals. No isomer shift was detected in comparing the metallic form of potassium with the potassium halides. An upper limit for the relative change in the nuclear radius of ^{40}K is $|\Delta R/R| \leq 4 \times 10^{-3}$. The measurements indicate that radiation damage following the (n,γ) reaction does not substantially diminish the recoilless fraction f in insulators or metals. (auth)

5792 K-SHELL INTERNAL-CONVERSION COEFFICIENTS OF THE 122-AND 136.4-keV GAMMA TRANSITIONS OF ^{57}Co. Mukerji, A.; Walker, W. W.; Dickins, O. B. Jr. (Univ. of Alabama, Tuscaloosa). Nuovo Cim. (10), 52B: 225-8(Nov. 11, 1967).

The conversion-electron and gamma spectra associated with the decay of ^{57}Co were measured using an Si(Li) electron spectrometer and a Ge(Li) gamma spectrometer. The K-conversion coefficients and multipolarities of the 122- and 136.4-keV transitions were determined as was the E2/M1 mixing ratio for the 122-keV transition. (D.C.W.)

5793 CROSS SECTIONS FOR PRODUCTION OF GAMMA RAYS BY 2.8-MeV NEUTRON INTERACTIONS: MEASUREMENTS AND COMPARISON WITH THEORY. Thompson, W. E.; Engesser, F. C.; Ferguson, J. M. (Naval Radiological Defense Lab., San Francisco). Trans. Amer. Nucl. Soc., 10: 523-4(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5794 SPECTROSCOPIC MEASUREMENT OF THE NUCLEAR SPIN AND MAGNETIC MOMENT OF ^{39}Ar. Traub, W. (Univ. of Wisconsin); Roesler, F. L.; Robertson, M. M.; Cohen, V. W. J. Opt. Soc. Amer., 57: 1452-8(Dec. 1967).

The nuclear spin and magnetic moment of argon 39 were determined by high-resolution optical spectroscopy, using a pressure-swept Fabry–Perot interferometer, photoelectric detection, and digital data processing. The ^{39}Ar was produced through the ^{39}K(n,p)^{39}Ar reaction by pile neutron irradiation of KF. The spectrum of ^{39}Ar was excited in a miniature hollow cathode cooled by liquid nitrogen. Helium was used as a carrier gas. By application of the intensity rules, the nuclear spin was determined to be $^7/_2$, in agreement with the shell model. Anomalous spin values which were measured from some lines were shown to be caused by self-absorption from excited states. Using the A value of −23.76 ± 0.04 mK (1 mK = 10^{-3} cm^{-1}) measured for the $1s_2$ level and the previous result for ^{37}Ar, the nuclear magnetic moment was determined to be −1.3 ± 0.3 nm. The measured B value for the $1s_2$ level is B = +2.80 ± 0.02 mK. Several level structures and isotope shifts are reported. (auth)

5795 EXCITATION OF ISOBARIC ANALOGUE STATES IN THE REACTION ^{27}Al(d,n)^{28}Si. Lawergren, B.; Morrison, G. C.; Ferguson, A. T. G. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys., A106: 455-63(1967).

A high-resolution study of the ^{27}Al(d,n) reaction has revealed five T = 0 and four T = 1 states formed prominently through $S_{\frac{1}{2}}$ transfer. The absolute spectroscopic factors satisfy the isospin sum rules of French and Macfarlane. The centroids of the T = 0 and T = 1 components differ by 3.5 ± 0.3 MeV. For comparative purposes, some spectroscopic factors were also extracted from previously published low-resolution data on the Al(d,n) and Al(d,p) reactions. (auth)

5796 THE g-FACTOR OF THE 184-keV STATE OF ^{67}Zn. Lieder, R. M.; Fleck, M.; Killig, K.; Forker, M.; Speidel, K.-H.; Bodenstedt, E. (Univ., Bonn). Nucl. Phys., A196: 389-400 (1967).

The angular correlation of the 209 to 184 keV γ−γ cascade in ^{67}Zn was measured to be $W(\theta) = 1 - (0.222 \pm 0.024)P_2(\cos\theta) + (0.027 \pm 0.033)P_4(\cos\theta)$. For the 184-keV transition, the E2/M1 mixing parameter, δ = +0.41 ± 0.06, was derived. The half-life of the 184-keV state was redetermined to be $T_{\frac{1}{2}}$ = 1.01 ± 0.05 nsec. The g-factor of the 184-keV state was determined by observing the integral rotation of the 209 to 184 keV γ−γ angular correlation in an external magnetic field of 31.2 kG. The result, g = +0.25 ± 0.08, is compared with the theoretical predictions of different nuclear models. (auth)

5797 AN UPPER LIMIT FOR THE POSITON DECAY OF ^{54}Mn. Berenyi, D. (Inst. of Nuclear Research, Debrecen, Hungary); Varga, D.; Vasvari, B.; Brucher, E. Nucl. Phys., A106: 248-50(1967).

An upper limit of 8×10^{-7} positon per decay of ^{54}Mn was set, and a corresponding upper limit of 0.37 was computed for the matrix element in the transition between the ground states of ^{54}Mn and ^{54}Cr. (auth)

5798 (n,d) REACTIONS ON ^{14}N, ^{35}Cl, ^{39}K, ^{40}Ca, AND ^{75}As AT 14.4 MeV. Miljanic, D.; Paic, G.; Antolkovic, B.; Tomas, P. (Inst. Ruder Boskovic, Zagreb). Nucl. Phys., A106: 401-16 (1967).

Angular distributions were measured for (n,d) reactions on ^{14}N, ^{35}Cl, ^{39}K, ^{40}Ca and ^{75}As leading to the ground state and some low excited states of the residual nuclei. The data were analyzed using the zero-range distorted-wave, Butler, and Dar theories. From the fit of the theoretical curves to the experimental angular distributions, the spectroscopic factors were extracted and were compared with those calculated on the basis of the shell model. Reasonable agreement between the experimental spectroscopic

factors and the corresponding shell-model predictions was obtained in all cases except for the $^{39}K(n,d_1)$ and $^{40}Ca(n,d_0)$ transitions. (auth)

5799 THE SPECTRUM OF ^{50}Ca AND THE REACTION ^{48}Ca (t,p). Broglia, R. A. (Univ. of Copenhagen); Federman, P.; Hansen, Ole; Hehl, K.; Riedel, C. Nucl. Phys., A106: 421-32 (1967).

The low-lying states of ^{50}Ca with $J^\pi = 0^+$ and 2^+ were calculated using effective matrix elements in the framework of the shell model obtained from a Hamada–Johnston potential. The calculated wave functions are used in connection with a distorted-waves procedure to generate cross sections for the $^{48}Ca(t,p)^{50}Ca$ reaction. A detailed comparison between theory and experiment is presented, and good agreement is obtained. (auth)

5800 THE ELASTIC AND INELASTIC SCATTERING OF 50 MeV PROTONS BY ^{64}Zn, ^{66}Zn, ^{68}Zn, AND ^{70}Zn. Calderbank, M. (King's Coll., London); Burge, E. J.; Lewis, V. E.; Smith, D. A.; Ganguly, N. K. Nucl. Phys., A105: 601-20(1967).

Differential cross sections are reported for elastic and inelastic scattering of 50 MeV protons from the four stable even isotopes of zinc. A magnetic spectrometer was used to resolve the various scattered proton groups including the 0^+ ground state, 2^+ first excited state and 3^- octupole state as well as some of the two-phonon triplets. Simple optical-model fits to the elastic scattering are reported, and the analysis of the inelastic cross sections is discussed. (auth)

5801 ISOSPIN CONSERVATION IN THE $^{40}Ca(d,\alpha)^{38}K$ REACTION. Hemsky, J. W.; Bleuler, E.; Tendam, D. J. (Purdue Univ., Lafayette, Ind.). Nucl. Phys., A105: 665-77(1967).

The angular distributions of the five most energetic alpha groups emitted in the reaction $^{40}Ca(d,\alpha)^{38}K$ at an incident energy of 9.20 MeV were measured with a broad-range spectrograph from 15° to 155°. The $\Delta T = 0$ isospin selection rule is found to inhibit the transition to the J^π, $T = 0^+$, 1 state at 0.129 MeV by about a factor 3. The corresponding isospin mixing in the compound nucleus, 20 to 25%, is considerably smaller than the nearly complete mixing previously reported by Jänecke for a deuteron energy of 7.7 MeV. This could be the predicted decrease at high excitation energies in the compound nucleus where $\langle H_C \rangle \ll \langle \Gamma \rangle$. The angular distribution is nearly symmetric about 90°, but a fit with a quadratic form of associated Legendre polynomials P_J^1 (cos θ) required very large cross terms which may indicate a deviation from a statistical compound-nucleus reaction larger than expected from the limited energy spread (about two coherence widths). The angular distribution of the transition to the 2^+, 1 state at 2.406 MeV has forward peaking and may have a direct interaction component in approximate agreement with the impurities in the initial and final states. A comparison of the angular distributions for the transitions to the three lowest $T = 0$ states at $E_d = 9.20$ MeV with previous work at 7.7, 11.4, and 14.8 MeV does not show any obvious general trends. (auth)

5802 ELECTRON CAPTURE IN ^{40}K. Azman, A.; Moljk, A.; Pahor, J. (Univ. of Ljubljana, Yugoslavia. Nuclear Inst. J. Stefan, Ljubljana, Yugoslavia). Z. Phys., 208: 234-7(1968).

The K-capture of the naturally radioactive isotope potassium-40 was studied using a special large proportional counter whose cathode, made of thin metallized polyester foil, was common to a ring of surrounding proportional counting units connected in anticoincidence. As the source, potassium cyanide evaporated in vacuum on the cathode and covered by antimony was employed. From the measured spectrum of K x-radiation of argon, the specific activity of potassium due to K-capture was determined to be 2.25 ± 0.25 disintegrations per sec per gram of natural potassium. This result yields for the ratio of K and (L + M + ...) electron-capture probabilities the value 0.44 ± 0.9. (auth)

5803 MUON CAPTURE IN ^{40}Ca. Bouyssy, A.; Castaignet, M.; Nguyen Vinh Mau (Instst itut de Physique Nucleaire, Orsay, Franch. Faculte des Science, Bordeaux, France). Phys. Lett., 25B: 533-5(Nov. 13, 1967).

The total muon capture rate in ^{40}Ca leading to ^{40}K is calculated in the hole-particle model. For the Goldberger-Treiman value of g_P/g_A, the result is only slightly larger than the available experimental value. The influence of second-class terms is then considered, and the variation of total rate with respect to the tensor coupling constant is given. (auth)

5804 INVESTIGATION OF THE ^{71}Ge, ^{73}Ge, AND ^{111}Pd EXCITED LEVELS BY MEANS OF THE STRIPPING (d,p) REACTION. Litvin, V. F.; Nemilov, Yu. A.; Gridnev, K. A.; (and others) (Leningrad State Univ.). Yadern. Fiz., 6: 688-95 (Oct. 1967). (In Russian).

Proton energy spectra and angular distributions were studied for the (d,p)-reactions on the isotopes $^{70,72}Ge$ and ^{110}Pd. A number of new excited levels of the final nuclei is determined. The cross-section is calculated in the distorted wave approximation. The orbital momenta l_n of the stripped neutrons were determined for several levels. The constant of the isospin term in the nuclear potential is found to be $V_1 = 125$ MeV in case of the volume form factor. The systematics of the isotopic shifts of various one-particle neutron levels is discussed as well as its relation to the shape of the form-factor corresponding to the isospin term in the nuclear potential. (auth)

5805 DETERMINATION OF TRANSITION MATRIX ELEMENTS OF ^{28}Si FROM EXPERIMENTS ON INELASTIC ELECTRON SCATTERING. Savitskii, G. A.; Afanas'ev, N. G.; Gul'karov, I. S.; Kovalev, V. D.; Omelaenko, A. S.; Khvastunov, V. M.; Shevchenko, N. G. Yadern. Fiz., 6: 685-7(Oct. 1967). (In Russian).

Differential cross sections of elastic and inelastic electron scattering are measured at incident electron energies 100 to 260 MeV. Results of the analysis of the inelastic scattering by means of the Born approximation are given for model-independent and model-dependent methods. (auth)

5806 NON-RADIATIVE INTERNAL PROCESSES ACCOMPANYING BETA-DECAY. Richards, K. C.; Rose, M. E. (Univ. of Virginia, Charlottesville). Contract AT(40-1)-2915. Phys. Lett., 25B: 25B: 501-3(Oct. 30, 1967). (ORO-2915-82).

The competition between internal pairs accompanying beta particles in the continuous spectrum and pairs emitted after decay to an excited state is examined. Applications are made to the ^{90}Y and ^{16}N decay schemes. The pairs accompanying K-capture are also studied and compared with competing positron emission in the decay of ^{210}At. Finally, internal conversion accompanying beta decay is compared to conversion electrons from the excited state formed in the ^{90}Y decay. In all cases the internal processes are slow, thus justifying existing branching ratio determinations between excited and ground state transitions. (auth)

5807 MEASUREMENT OF THE ELECTRON CAPTURE RATIO P_L/P_K OF ^{56}Ni AND ^{57}Ni BY USE OF DICYCLOPENTADIENYLNICKEL. Winter, G.; Holmuth, K.; Ross, R.; Kaestner, H.; Schintlmeister, J. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Z. Phys. Chem. (Leipzig), 234: 305-16(Feb. 1967). (In German).

By use of the vapor-forming compound dicyclopentadienylnickel, the electron capture ratio P_L/P_K for the nuclides ^{56}Ni and ^{57}Ni were determined with a multiwire proportional counter. For ^{56}Ni the value obtained was $P_L/P_K = 0.115 \pm 0.006$ and for ^{57}Ni $P_L/P_K = 0.100 \pm 0.006$. For the synthesis of dicyclopentadienylnickel a new method was developed. The results were compared with other experimental values and with calculated values of the capture ratio. (tr-auth)

5808 ISOBARIC-SPIN ANALOGUE RESONANCES IN ^{90}Zr FROM PROTON INELASTIC SCATTERING. Long, Dale Donald. Tallahassee, Florida State Univ., 1966. 106p.

Thesis.

Compound nucleus resonances were observed in ^{90}Zr through the reaction $^{89}Y(p,p')^{89*}Y$. These resonances are interpreted as isobaric-spin analogues of low-lying levels in ^{90}Y. The experiment was performed using the Florida State University 12-MeV tandem Van de Graaff accelerator. The out-going protons from the reactions were analyzed in a broad-range magnetic spectrograph operated in the spectrometer mode. Excitation functions for incoming proton energies between 5.5 and 11 MeV were taken for the four cases in which the residual nucleus was left in each of the first four excited states. Angular distributions were taken on all prominent resonances observed. The results were analyzed in terms of a general expression for the differential reaction cross-section which was written in terms of an undefined scattering matrix. The j-j coupling scheme was used. Tentative assignments were made for the spins, parities and orbital angular momentum values for the observed resonances. The results were compared with the predictions of the "weak-coupling" model. (Disser. Abstr.)

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Refer also to abstracts 5722 and 5779.

5809 (ANL–7354) PHYSICS DIVISION SUMMARY REPORT. Annual Review, April 1, 1966–March 31, 1967. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 165p. Dep. CFSTI.

A number of experimental investigations of nuclear decay schemes, level schemes, and reactions are summarized, as is progress in the development of the shell model and the theory of nuclear matter. The modification of a cyclotron to operate as a variable-energy device is reported, as are developments in ion sources and spectrometers. Information on research in plasma physics, radiation chemistry, the reactions of charged-particle beams with monocrystals, and ion desorption is also included. (D.C.W.)

5810 (ANL–7363) FAST-NEUTRON SCATTERING FROM TANTALUM, RHENIUM, AND PLATINUM. Smith, A. B.; Guenther, P. T.; Hayes, R.; Whalen, J. F. (Argonne National Lab., Ill.). Aug. 1967. Contract W-31-109-eng-38. 54p. Dep. CFSTI.

The scattering of neutrons with energies ≤1.5 MeV from tantalum, rhenium, and platinum was studied experimentally. Elastic and inelastic neutron scattering angular distributions were determined at incident neutron-energy intervals of ≤20 keV throughout the range 0.3 to 1.5 MeV. Time-of-flight measurements were made concurrently at eight or more scattering angles between 25 and 155° with sufficient scattered neutron energy resolution to separate the elastic scattered component from most inelastic scattered neutron groups. Differential inelastic scattering cross sections were observed corresponding to the excitation of states: in tantalum at 144 ± 10 (doublet), 313 ± 15, 506 ± 20, 620 ± 20, 720 ± 20, and 930 ± 25 keV; in rhenium at 132 ± 10, 219 ± 15, 313 ± 15, 387 ± 18, 518 ± 20, 637 ± 20, 767 ± 25, 865 ± 25, 963 ± 25, 1060 ± 25, and 1135 ± 25 keV; and in platinum at 130 ± 20, 214 ± 20, 348 ± 15, 420 ± 15, 620 ± 20, 719 ± 15, 838 ± 25, and 935 ± 20 keV. The experimental results were compared with calculations based upon the optical model and the Hauser–Feshbach formula inclusive of corrections for resonance-width fluctuations. The experimentally observed level structure is discussed in the context of single-particle and rotational states of deformed nuclei. (auth)

5811 (EURFNR–400) ENERGY AND TEMPERATURE DEPENDENT CAPTURE MEASUREMENTS BELOW 30 keV SUPPORTING DOPPLER EFFECT CALCULATIONS. Seufert, H.; Stegemann, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Oct. 1967. 25p. (EUR–3675e; KFK–631; CONF–671043–10). Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

From Symposium on Fast Reactor Physics and Related Safety Problems, Karlsruhe, Germany.

Energy- and temperature-dependent capture measurements below 30 keV neutron energy were performed in natural uranium, tungsten, and tantalum using the slowing-down-time spectrometer technique. The experimental setup used for the experiments consists of a lead block of 1.3-m side length containing two experimental channels of 10 × 10 cm² cross section. Into the first channel the target of a 14-MeV neutron generator is introduced, whereas the second channel is used for insertion of the heated samples. Pulses of 14-MeV neutrons having a pulse width of about 1/usec are used. The neutron energy is degraded first by inelastic collisions; afterwards only elastic collisions take place so that a specific relationship holds between mean neutron energy in the lead pile and the time after occurrence of the neutron pulse. Due to this time energy relation, a time analysis procedure for the detector counts is applied. Because the energy range below 30 keV neutron energy is most interesting for Doppler-effect investigations the slowing-down-time spectrometer is used to measure the capture ratios of hot-to-cold samples of natural uranium, tungsten, and tantalum. Thin samples were heated to different temperatures for this purpose, and the capture γ rays were detected by proportional counters. Because hot-to-cold capture ratios are measured the knowledge of the neutron flux is not necessary; therefore, a direct comparison of calculated and measured temperature-dependent cross sections is possible. A theoretical analysis of the experimental data for uranium is given. (auth)

5812 (INR-817/IA/PL) ENERGY DISTRIBUTION OF LONG RANGE α PARTICLES EMITTED DURING THE THERMAL NEUTRON FISSION OF ^{235}U. Sowinski, M.; Chwaszczewska, J.; Dakowski, M.; Gadomski, A.; Krogulski, T.; Piasecki, E.; Piekarz, H. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 16p. Dep.

The energy spectrum of the long range α particles emitted in the thermal neutron fission process of ^{235}U was measured. A good fit was found using the Gaussian distribution. The relative cross section for thermal and resonance neutrons was determined. An attempt to estimate the yields of the other charged particles emitted in the ternary fission was made. (auth)

5813 (INR-P–812/IA/PL) EFFECT OF THE ONE-PHONON ADMIXTURES ON THE M1 AND E2 TRANSITION RATES IN ^{125}I AND ^{127}I. Kownacki, J.; Ludziejewski, J.; Moszynski, M. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 20p. Dep.

On the basis of these measurements, reduced transition probabilities, B(M1) and B(E2), were established; and the results were compared with the predictions of the single-particle model as well as with the pairing-plus-quadruple force model used by L. S. Kisslinger and R. A. Sorensen for spherical nuclei. (auth)

5814 (JINR–P6–3464) O SKHEME RASPADA ^{158}Ho. (On the Decay of ^{158}Ho). Abdurazakov, A. A.; Vrzal, Ya.; Gromov, K. Ya.; Zhelev, Zh. T.; Kalinnikov, V. G.; Liptak, Ya.; Li Sang Kyn; Mukhtasimov, F. N.; Nazarov, U. K.; Urbanets, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 28p. (In Russian). Dep.

The γ spectra were investigated using a Ge(Li) γ spectrometer, and the conversion-electron spectra in β^+ decay of ^{158} + ^{158m}Ho were measured using a magnetic spectrometer. More than 100 previously unreported γ lines and three components of the β^+ decay (1300 ± 30; 1850 ± 25; 2890 ± 20 keV) were detected. The existence of a double quasi-particle level at 1895 keV of the type (4^+) n $5/2^-$ (523) + n $3/2^-$ (521) was shown. Conclusions were made on the quantum character of the ground state of ^{158}Ho(5+). The experimental and theoretical ratios of the reduced probability of E2 transition of ^{158}Dy between bands with $Z^\pi = 2^+$ and $K^\pi = 0^+$ were compared. Vibrational bands of 986.1 keV (0^+) and 1085 keV (2^+) were proposed. More than 20 previously unreported levels were proposed in the decay scheme of ^{158} + ^{158m}Ho. Data were given on the population of the levels of ^{158}Dy. The mass difference of the nuclides ^{158}Ho and ^{158}Dy was determined to be 4220 ± 30 keV. A decay scheme for ^{158} + ^{158m}Ho was discussed. (tr-auth)

5815 (JINR–P6–3468) OB IZOMERNYKH SOSTOYANIYAKH TIPA $I^\pi = 11/2^-(h_{11/2}-)^{137}$Nd I ^{137}Pr NOVYI IZOTOP ^{136}Nd. (Isomeric State of $I^\pi = 11/2^-(h_{11/2}-)^{137}$Nd and ^{137}Pr Type. The New Isotope ^{136}Nd). Zhelev, Zh. T.; Kalinnikov, V. G.; Liptak, Ya.; Peker, L. K. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 19p. (In Russian). Dep.

The previously unknown isotope ^{136}Nd was identified. The decay scheme ^{136}Nd $\xrightarrow{55\ min}$ ^{136}Pr $\xrightarrow{13.5\ min}$ ^{136}Ce was proposed. It was shown that the nucleus ^{137}Nd has an isomeric state of the type $h_{11/2}$($T_{1/2}$ = 55 min). The half-life 22 ± 2 min was attributed to the ground state of ^{137}Nd $(d_{3/2})$. (tr-auth)

5816 (JINR–P6–3492) VREMYA ZHIZNI UROVNYA 242,8 keV V YADRE ^{165}Er. (Lifetime of the 242,8-keV Level in ^{165}Er Nuclei). Adylov, G. T.; Babadzhanov, R.; Kuchma, A. S.; Morozov, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 13p. (In Russian). Dep.

Using a multichannel analyzer with a time-to amplitude converter, the lifetime of the 242.8-keV level in ^{165}Er from the decay of ^{165}Tm ($T_{1/2}$ = 29 hrs) was measured. The coincidences of the conversion electrons of the 242.8-keV transition with the γ rays with energy above 1132 keV were analyzed. The half-life of the 242.8-keV level was found to be 3.21 ± 0.51 × 10^{-10} sec. F_M and F_N were determined for the transitions with the energy 242.8 (keV) (M1 + E2); 195.7 (E1); and 165.6 (E2) going from this state to the states $5/2^-$, $5/2^-$[523]↓; $5/2^-$, $5/2^+$[642]↑, and $7/2^-$, $5/2^-$[523]↓, respectively. (tr-auth)

5817 (NYO-GEN–72–28) PEGRAM NUCLEAR PHYSICS LABORATORIES PROGRESS REPORT FOR JANUARY 1965 TO JANUARY 1966. (Columbia Univ., New York. Dept. of Physics). Contract AT(30-1)-Gen-72. 170p. Dep. CFSTI.

PLUTONIUM-239 — neutron fission of, fragment energies and yields from, (E)
NEON-20 — helium-3 reactions (He-3,n) at 3 to 4.3 MeV, magnesium-22 energy levels from, (E)
CALCIUM-48 — proton reactions (p,n) with, scandium-48 energy levels from, (E)
ION SOURCES — development for Van de Graaff accelerators, (E)
COMPUTER PROGRAMS — for analysis of γ–γ angular correlation measurements in aligned nuclei,
CALCIUM-44 — energy-level spins from proton inelastic scattering, (E)
CALCIUM-42, TITANIUM-48, CHROMIUM-50, NICKEL-60 — energy levels and transitions, (E)
ARGON-40 — mass difference of 1478 ± 5 keV from potassium-40, (E)
CALCIUM-40 — energy-level transitions, double gamma emission in $0^+ \rightarrow 0^+$, (E)
BERYLLIUM-10 — energy levels of, doublet, (E)
CALCIUM-48 — beta decay of, equipment for detecting double, (E)
BROMINE-82 — beta decay of, krypton-82 energy levels from, (E)

POSITRONIUM — annihilation of, correlation between decay lifetimes and angular distributions in two-photon, (E)
ATOMS — X-radiation from μ-mesic, high-resolution studies of, (E)
BISMUTH-209 — x-radiation spectra of μ-mesic, (E)
NEODYMIUM-142, NEODYMIUM-144, NEODYMIUM-146, TIN-118, TIN-119, TIN-120 — x radiation spectra of μ-mesic, isotopic shift in, (E)
TUNGSTEN-182, TUNGSTEN-184, TUNGSTEN-186 — x-radiation spectra of μ-mesic, isotopic shift and electric quadrupole effects in, (E)
URANIUM-238, SAMARIUM-152 — x radiation spectra of μ-mesic, electric quadrupole effects in, (E)
AMMONIUM PERCHLORATES, AMMONIUM CHROMATES, AMMONIUM HALIDES — neutron scattering by, temperature effects on slow, (E)
ION BEAMS — controller for precision magnet regulator for, (E)
RADIATION DETECTORS, SEMICONDUCTOR (GERMANIUM) — preamplifier for use with, low-noise charge-sensitive, (E)
AMPLIFIERS — design of fast, design of linear, (E)
PULSE CONVERTERS — design for 100 ns range, (E)
ELECTRONIC EQUIPMENT — pulse shape discriminators, design of; photomultiplier head, design of regulated dynode; tunnel diode set-reset device, design of, (E)
VOLTAGE REGULATORS — design for use with AEC standard bins, (E)

5818 (RT/FI-(67)13) MISURA DEL FATTORE DI TRASPARENZA ALLE RISONANZE IN RETICOLI AD URANIO NATURALE MODERATI A D_2O E REFRIGERATI A DIPHYL. (Measurement of Resonance Cross Section in a Natural Uranium Lattice Moderated by D_2O and Cooled with Diphenyl). Canalini, D.; Cecchi, P. F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 44p. (In Italian). Dep.

The measurement of the transparency factor at the resonance in a cluster was made either by the determination of the initial conversion ratio τ_0 or from ρ_{28}. The measurement method is described in detail and the counting techniques are reported. The experimental results are tabulated. The experimental data are compared with the theoretical data calculated using the PLUARTHCO code. The agreement was satisfactory. (J.S.R.)

5819 (WAPD-TM-613) INTEGRAL MEASUREMENTS OF THE EPITHERMAL NEUTRON CAPTURE-TO-FISSION CROSS-SECTION RATIOS OF ^{233}U AND ^{235}U. LWB-LSBR Development Program. Conway, D. E.; Gunst, S. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1967. Contract AT(11-1)-Gen-14. 48p. Dep. CFSTI.

Samples of uranium enriched in ^{233}U and in ^{235}U were irradiated with cobalt monitors in high-flux facilities in both cadmium-covered and bare assemblies. Mass-spectrometric and radiochemical analyses of irradiation samples provide data concerning thermal and epithermal capture and fission reactions from which experimental results are obtained. The epithermal capture-to-fission cross-section ratios of ^{233}U and ^{235}U at infinite dilution are 0.175 ± 0.006 and 0.499 ± 0.016, respectively, for a 1/E spectrum with a low-energy cut-off of 0.50 eV. Resonance integrals for capture and fission are evaluated in terms of cobalt cross sections. (auth)

5820 NUCLEAR FISSION. Obukhov, A. I.; Perfilov, N. A. Usp. Fiz. Nauk, 92: 621-77(Aug. 1967). (In Russian).

A review is given of experimental data on nuclear fission within a wide range of fissionable nuclei and excitation energies. An analysis is also made of the basic postulates and assumptions on nuclear fission within the framework of a model for a liquid drop and O. Bohr's hypothesis. Latest data on the lifetime of nuclei in relation to spontaneous fission, $T_{\frac{1}{2}}$ (sp), are given in the form of the relation $T_{\frac{1}{2}}$ (Z^2/A). Data are also cited on a recently discovered phenonemon — the spontaneous fission of nuclei in the isomeric state. The dependence of the cross section of induced nuclear fission on the energy of bombarding neutrons, charged particles, and gamma quanta is traced. Data are presented on the described characteristics of the energy dependence of the relation T_f/T_n for heavy and relatively light nuclei in the region of average energy excitations (where T_f is the level width and T_n is neutron width). The lack of sufficient information on the nature of the energy dependence G_f/G_n within the range of high-energy nuclear excitations is pointed out. An analysis is made of data on the mass, charge, and angular distribution, and kinetic energy of fission fragments, and on neutrons, gamma quanta, and charged particles emitted in nuclear fission. Available data on the angular anisotropy of nuclear fission fragments point to a considerable dependence of the angular distribution of the fragments on the character and number of transition states and channels. The possible influence of structural and shell effects of nuclear fission on the character of the mass and charge distribution of fission fragments, the magnitude of the kinetic energy of fission fragments, and the number of emitted neutrons and gamma quanta, is discussed. The possibility of explaining the nature of fission in highly excited nuclei within the framework of a model of a liquid drop is examined. The contradiction between the computed and experimentally observed dependence of the yield of delayed neutrons on the excitation energy of heavy nuclei is discussed. (auth) (CFSTI)

5821 CORIOLIS INTERACTION EFFECT IN ^{163}Dy. Bondarenko, V. A.; Prokof'ev, P. G. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 4, 11-17(1967). (In Russian).

The spectrum of internal conversion electrons emitted by ^{163}Dy after neutron capture was measured by means of a β spectrometer in the energy range of 36 to 650 keV with a resolution of 0.3 to 0.4%. The multipolarities and intensities of transitions are determined. Intensities of the low-energy transitions within rotational bands [521↓], [521↑] and between them are explained on the basis of the Nilsson model, taking into account the Coriolis interaction between rotational bands. (auth)

5822 THE HARDER GAMMA RAYS OF ^{191}Os. Agin, G. P.; Clark, G. E.; Mandeville, C. E.; Potnis, V. R. (Kansas State Univ., Manhattan). Nuovo Cim. (10), 52B: 220-1(Nov. 11, 1967).

The spectrum of gamma rays emitted in the decay of ^{191}Os was measured using a Ge(Li) detector with a depletion layer of 4.2 mm. The energies and relative intensities were determined. It was found that the 187-keV gamma activity previously attributed to a state in ^{191}Ir is actually associated with the induced activity of an impurity. (D.C.W.)

5823 ANALYSIS OF THE DECAY OF THE TWO-NEUTRON 8^- STATE IN ^{176}Yb. Bocciolini, M.; Cambi, A.; Fazzini, T. F.; Maurenzig, P. B. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Nuovo Cim. (10), 52B: 229-32(Nov. 11, 1967).

The gamma spectrum from the decay of ^{176m}Yb was investigated. The E1 character of the 95.9-keV isomeric transition and the spin-parity assignment of 8^- for the 1050-keV isomeric state were confirmed. The total conversion coefficient for the 95.9-keV transition was determined. (D.C.W.)

5824 MEASUREMENTS AND CALCULATIONS OF THE CHANGE IN THE FISSION INTEGRAL AND CAPTURE-TO-FISSION RATIO FOR ^{235}U IN THE INTERVAL 293 TO 1100^0K IN AN EPITHERMAL SPECTRUM. Green, L. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 618-19(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

5825 CORRELATION OF RESONANCE PARAMETERS AND INTERPRETATION OF η/ν IN ^{239}Pu BELOW 20 eV. Adler, F. T.; Adler, D. B. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc., 10: 619-20(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

5826 CAPTURE CROSS SECTIONS OF ^{127}I AND ^{115}In IN THE keV REGION. Furr, A. Keith (Virginia Polytechnic Inst., Blacksburg); Tucker, J. R.; Lindsay, J. G. Jr. Trans. Amer. Nucl. Soc., 10: 616(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

5827 FISSION-PRODUCT DECAY FROM FAST FISSION OF ^{239}Pu. Battat, M. E.; Dudziak, Donald J.; Hicks, H. R. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 10: 524-5(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

5828 ^{235}U FISSION NEUTRON SPECTRUM: 6 TO 20 MeV. Sherwood, G. G. (Dept. of Air Force, Andrews Air Force Base, Washington, D. C.); King, J. S. Trans. Amer. Nucl. Soc., 10: 555(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

5829 GAMMA-RAY PRODUCTION IN REACTOR AND SHIELDING MATERIALS DUE TO FAST-NEUTRON INTERACTIONS. Morgan, I. L. (Texas Nuclear Corp., Austin). Trans. Amer. Nucl. Soc., 10: 523(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

5830 GAMMA-RAY SPECTRA FROM THE CAPTURE OF EPITHERMAL NEUTRONS. Chrien, R. E. (Brookhaven Na-

tional Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 522 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5831 STATE-OF-THE-ART IN NEUTRON CAPTURE GAMMA RAYS. Bartholomew, G. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Amer. Nucl. Soc., 10: 522(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5832 EXPERIMENTAL TECHNIQUES AND METHODS FOR THE PRODUCTION OF HIGH-ENERGY MONOENERGETIC GAMMA RAYS USING THE TECHNIQUES OF NUCLEAR RESONANCE FLUORESCENCE. Ramchandran, S. (Texas A and M Univ., College Station). Trans. Amer. Nucl. Soc., 10: 454-5 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5833 ON THE NUCLEAR PROPERTIES OF THE ISOTOPES ^{256}103 AND ^{257}103. Flerov, G. N.; Korotkin, Yu. S.; Mikheev, V. L.; Miller, M. B.; Polikanov, S. M.; Stchegolev, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., A106: 476-80(1967).

The isotopes ^{256}103 and ^{257}103 were synthesized by bombarding ^{243}Am with ^{18}O ions. The assignment was based on the excitation functions of the reactions ^{243}Am(^{18}O,5n)^{256}103 and ^{243}Am(^{18}O,4n)^{257}103. The isotope ^{256}103 has a complicated alpha spectrum in the range $8.35 \leq E_\alpha \leq 8.60$ MeV. An intense group of alpha particles has $E_\alpha = 8.42$ MeV. The measured half-life for ^{256}103 is about 35 sec. The obtained experimental data permit us to conclude that ^{257}103 has $T_{1/2} \approx 35$ sec and $8.5 \leq E_\alpha \leq 8.6$ MeV. (auth)

5834 NOTE ON THE ENERGY DEPENDENCE OF THE β-γ DIRECTIONAL CORRELATION IN THE DECAY OF ^{154}Eu. Zganjar, E. F.; Hamilton, J. H.; Ramayya, A. V. (Vanderbilt Univ., Nashville). Nucl. Phys., A196: 449-54(1967).

The 1855 keV-123 keV β-γ directional correlation in the decay of ^{154}Eu was measured as a function of beta energy. A magnetic-lens spectrometer was used as the beta-energy analyzer. The attenuation of the directional correlation was carefully studied. The maximum measured value of A_2 corrected for attenuation is –0.31 at 1638 keV and decreases rapidly with decreasing energy. (auth)

5835 A SHORT-LIVED ISOMER ^{194m}Ir. Lundan, A.; Siivola, A. (Reactor Lab., Ontaniemi, Finland). Nucl. Phys., A196: 417-20(1967).

An isomeric state of ^{194m}Ir with a half-life of 30 ± 2 msec was studied with a rapid pneumatic transport and a Ge(Li) spectrometer. Both natural iridium and enriched isotopes were irradiated with reactor neutrons, and their gamma spectra were measured quickly after irradiation. The K x rays and two gamma rays with energies 84 ± 2 and 112 ± 2 keV were observed in the decay of ^{194m}Ir. (auth)

5836 COLLECTIVE STATES IN THE ODD NUCLEUS ^{170}Tm FROM DEUTERON INELASTIC SCATTERING. Fransson, K. (Research Inst. for Physics, Stockholm. Univ of Stockholm); Ryde, H.; Herskind, B.; Symons, G. D.; Tveter, A. Nucl. Phys., A196: 369-81(1967).

The cross sections for inelastic scattering of 5.5 and 12 MeV deuterons from the odd nucleus ^{170}Tm were measured at several angles with a high-resolution, heavy-particle spectrograph. Rotational states with spins up to 7 were observed in the K = 1 ground-state band, and a tentative assignment is made for the 4$^-$ member of the K = 0 band based on the state at 150 keV. The B(E2) values for excitation of the 2$^-$ and 3$^-$ states of the K = 1 band and the 2$^-$ state of the K = 0 band were measured; the value of the intrinsic quadrupole moment Q_0 for the K = 1 band is found to be 7.78 ± 0.16 b. The possibility of states at 920 and 1690 keV being the lowest members of the $|K-2|$ and K + 2 gamma-vibrational bands is also discussed. (auth)

5837 THE DECAY OF ^{195}Ir AND ^{195m}Ir. Hofstetter, K. J.; Daly, P. J. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1672. Nucl. Phys., A106: 382-8(1967). (COO-1672-4).

By studying the iridium activities produced in α-particle bombardments of enriched ^{192}Os, the activity currently assigned to ^{195}Ir decay has been identified as that of ^{81}Rb, arising from reactions induced in target impurities. In ^{195}Ir decay, the following γ rays were identified (relative intensities in parentheses): 98.7 (100), 119.5 (3), 129.6 (14), 140.2 (6), 172.7 (42), 201.1 (10), 211.2 (26), 239.8 (13), 252.0 (12), 287.3 (8), 290.4 (14), 307.0 (10), 319.3 (62), 359.0 (26), 365.1 (50), 409.0 (5), 433.0 (65), 480.7 (15), 685.2 (76), and 799.8 keV (7). The 98.7- and 129.6-keV γ rays decay with a 2.8 ± 0.1-hr half-life, and they are assigned to ^{195}Ir ground-state decay. The other γ rays decay with a 4.0 ± 0.15-hr half-life, and they are assigned to a new isomer ^{195m}Ir. (auth)

5838 INVESTIGATION OF GAMMA RAYS IN THE DECAY CHAIN ^{149}Gdyields^{149}Euyields^{149}Sm. Adam, I. (Univ. of Copenhagen); Toth, K. S.; Meyer, R. A. Nucl. Phys., A196: 275-88 (1967).

Gamma-ray spectra were measured with a Ge(Li) detector for the decay chain ^{149}Gd(9d) → ^{149}Eu(106d) → ^{149}Sm. Results were compared with previously known data for transitions following the decay of the same two nuclides. By combining several sets of conversion-electron and γ-ray intensities, K-shell internal conversion coefficients were calculated for and probable multipolarities were assigned to ^{149}Gd transitions that had been observed in both γ-ray and conversion-electron spectra. These transition intensities and multipole orders were found to be consistent with a partial decay scheme that features excited states in ^{149}Eu at energies of 149.8, 496.6, 534.4, 666.6, 749.1, 795.1, 939.1, 956.9, and 1097.8 keV. Intensities measured in this study for γ-rays following ^{149}Eu decay were found to agree with a recently published set of intensity values. Here again, K-shell internal conversion coefficients were calculated by combining conversion-electron and γ-ray data. An e-γ[Ge(Li)] coincidence measurement yielded additional evidence for the existence of ^{149}Sm excited levels at energies of 22.5, 277.0, 350.0 and 528.5 keV. (auth)

5839 GAMMA SPECTRUM OF ^{106m}Ag. Moragues, J. A. (Comision Nacional de Energia Atomica, Buenos Aires); Reyes-Suter, P.; Suter, T.; Perez, M. Nucl. Phys., A106: 289-95(1967).

The gamma spectrum of the decay of ^{106m}Ag(8d) was measured with a Ge(Li) detector. The following energies in keV and relative intensities (in parentheses) were determined: 194.93 (6), 221.51 (83), 228.53 (29), 328.27 (18), 375.1 (3), 390.90 (43), 406.00 (152), 418.6 (7), 429.46 (161), 450.80 (310), 474.2 (12), 511.77 (1000), 586.0 (9), 600.88 (23), 616.05 (236), 645.5 (18), 680.3 (25), 703.3 (52), 717.1 (320), 748.2 (227), 792.8 (65), 803.9 (124), 807.5 (42), 824.5 (160), 847.5 (45), 875 (7), 956 (8), 1019.7 (9) 1045.7 (285), 1053 (11), 1121 (9), 1127.8 (106), 1199.1 (106), 1222.8 (61), 1394.2 (17), 1527.0 (155), 1565 (8), 1572.1 (70), 1691 (0.5), 1722.1 (15), 1770 (0.6), 1793 (0.6), 1837.9 (20), and 2082 (0.2). All but two of the transitions were placed into a decay scheme with the following levels (in keV): 511.77 (2$^+$), 1127.8 (2$^+$), 1228.9 (4$^+$), 1557.3 (3$^+$, 4$^+$), 1931.8 (3$^+$, 4$^+$), 2076.7 (3$^+$, 4$^+$), 2083.8 (3$^-$), 2282.0? (3$^+$, 4$^+$), 2305.3 (4$^-$), 2350.2 (3$^+$, 4$^+$), 2365.2? (3$^+$, 4$^+$), 2756.2 (5$^+$), and 2951.1 (5$^+$). (auth)

5840 NEW MERCURY ISOTOPES. Demin, A. G.; Fenyes, T.; Mahunka, I.; Subbotin, V. G.; Tron, L. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., A106: 337-49(1967).

Products of the reactions ^{170}Yb + ^{20}Ne, ^{147}Sm + ^{40}Ar and ^{169}Tm + ^{22}Ne were collected by the helium sweeping technique, and their α radiation was analyzed with a semiconductor spectrometer. The following measurements were carried out: energies of α particles E_α, half-lives $T_{1/2}$ of the observed emitters and the excitation functions of the reactions leading to their production. New α groups were identified as new isotopes of mercury including ^{179}Hg, ^{180}Hg, ^{182}Hgα_0, ^{182}Hgα_1, and ^{183}Hg. Data were also obtained on the α-decay of ^{185}Hg, ^{179}Au, ^{181}Au, ^{183}Au, ^{185}Au, ^{176}Pt, ^{177}Pt, ^{178}Pt and ^{180}Pt, which agree with previous results. (auth)

5841 DECAY OF ^{139}Pr. De Frenne, D.; Demuynck, J.; Dorikens-Vanpraet, L. (Univ., Ghent). Nucl. Phys., A196: 350-6(1967).

The decay of ^{139}Pr was investigated by means of NaI(Tl) and high-resolution Ge(Li) spectrometers. Accurate energy and relative intensity determinations of the gamma rays were performed. Levels of ^{139}Ce at 255.15, 1320.0, 1346.8, 1595.6, 1630.7, 1729.8, 1818.0, 1907.0 and 2015.0 keV were deduced. The existence of the 255.15 keV level was confirmed by gamma-gamma coincidence measurements. Spin and parity assignments for all observed levels were given from electron capture and positon disintegration considerations and gamma branches. (auth)

5842 SPECTROSCOPIC INFORMATION ON THE ^{127}I LEVELS THROUGH NEUTRON SCATTERING. Sharma, H. C.; Nath, N. (Banaras Hindu Univ., Varanasi, India). Nucl. Phys., A196: 241-7(1967).

The Hauser-Feshbach theory was used to evaluate excitation functions for neutron inelastic scattering to states of ^{127}I. The results are compared with experimental data in the energy range 60 keV to 900 keV. Specific spin assignments for the first four levels are proposed. A new interpretation of the spin assignments of the levels around 600 keV is given. A discrepancy was found for the 58-keV first excited state, and measurements are proposed to clarify it. (auth)

5843 EXCITATION FUNCTIONS FOR (p,n) AND (p,2n) INTERACTIONS IN Sc, Cr, Mo, Cd, AND W BETWEEN 8 AND 14 MeV. Thomas, Richard G. Jr.; Bartolini, W. (Univ. of California, Livermore). Contract W-7405-eng-48. Nucl. Phys., A196: 323-36(1967). (UCRL-70446).

Using a large liquid scintillator, neutron production in Sc, Cr, Mo, Cd and W by the interaction of 8 to 14 MeV-protons was measured. The (p,n) cross section in Sc is practically constant over the energy range studied. Moreover, the rapid rise that is frequently observed in the (p,2n) cross section above threshold is noticeably absent in this element. Although the maximum energy used is almost 2 MeV above the ^{45}Sc(p,2n) energetic threshold, the (p,2n) cross section is too small to be measurable by our technique. It is estimated that it is ≤10 mb at 14 MeV. The data were analyzed in terms of statistical theory. Two different forms of the nuclear level density function ω were employed. In most cases it was found that $\omega = \text{const} \exp 2(au)^{1/2}/u^2$ gave somewhat better agreement with experiment than did $\omega = \text{const} \exp 2(au)^{1/2}$. (auth)

5844 NUCLEAR ENERGY STATES OF ^{155}Eu. Agin, G. P.; Mandeville, C. E.; Potnis, V. R. (Kansas State Univ., Manhattan). Nucl. Phys., A105: 698-704(1967).

Isotopically concentrated ^{154}Sm was irradiated in a research reactor to produce ^{155}Sm which decays by beta emission to ^{155}Eu. A total of 29 gamma rays observed in Ge(Li) detectors was ordered in a level scheme which contains levels having the following excitation energies in keV, spins, and parities: 0($5/2^+$), 79($7/2^+$), 105($5/2^-$), 168($7/2^-$), 246($9/2^+$), 307($5/2^+$), 614($7/2^-$), 768($1/2^+$), 782($3/2^+$), 876($5/2^+$) 1102($5/2^-$), 1264($1/2^-$, $1/2^+$, $3/2^+$) and 1302($1/2^-$, $1/2^+$, $3/2^+$). These states of ^{155}Eu were assigned Nilsson numbers or rotational properties. (auth)

5845 COINCIDENCE AND DIRECTIONAL CORRELATION MEASUREMENTS ON THE DECAY OF ^{156}Tb(5.3 d). Kenealy, P. F.; Funk, E. G.; Mihelich, J. W. (Univ. of Notre Dame, Ind.). Nucl. Phys., A105: 522-44(1967). (COO-498-63).

Coincidence and γ-γ directional correlation measurements on the decay of ^{156}Tb to levels in ^{156}Gd were carried out gating with 2 mm or 5 mm Ge(Li) detectors and displaying the spectrum of a 7.6 cm × 7.6 cm NaI detector. The dipole-quadrupole mixtures were determined for transitions of 262, 534, 960, 1065, 1066, 1159, 1222, 1333, 1644 and 1844 keV depopulating intrinsic levels above 1.5 MeV as well as levels at 1154, 1249 and 1355 keV in the gamma-vibrational band. The energies and intensities of previously unobserved transitions of 579.3, 690, 747, 805, 855, 1129, 1188, 1228, 1240, 1265, 1814, 1885, 1889 and 2047 keV were measured using Ge(Li) detectors. The available internal conversion electron data were used in conjunction with the photon data to calculate internal conversion coefficients. Branching ratios for E2 transitions de-exciting levels in the gamma band and E1 transitions de-exciting the negative parity states were calculated and compared with theoretical estimates. A revised decay scheme is presented. (auth)

5846 MEASUREMENT OF MAGNETIC MOMENTS OF THE LOWEST 2^+ STATES IN SOME Dy, Er, AND Yb ISOTOPES. Muenck, Eckard (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 208: 184-207(1968). (In German).

With the Mössbauer technique, the hyperfine splittings of the lowest 2^+-states of some Dy, Er, and Yb isotopes were observed at 4.2°K in the paramagnetic compounds Dy-Al garnet, $ErCl_3 \cdot 6H_2O$, and $YbCl_3 \cdot 6H_2O$. Most of the sources were produced by photonuclear reactions. Ratios of g-factors for neighboring isotopes could be determined with small systematic errors. The results are: $g^{164}/g^{166} = 1.103(15)$, $g^{166}/g^{168} = 0.960$ (13) for Er, and $g^{170}/g^{172} = 1.009$ (15), $g^{170}/g^{174} = 0.994$ (13) for Yb. Using known values for the effective magnetic fields at the nuclei, the following g-factors were obtained: ^{164}Dy, 0.336 (14); ^{164}Er, 0.353 (10); ^{166}Er, 0.320 (8); ^{168}Er 0.333 (8); ^{170}Yb, 0.335 (6); ^{172}Yb, 0.332 (8); and ^{174}Yb, 0.337 (8). (auth)

5847 ON THE DISINTEGRATION ENERGIES OF ^{174}Lu ISOMERS. Liukkonen, E.; Kantele, J. (Univ. of Helsinki). Z. Phys., 208: 208-14(1968).

Direct capture-ratio measurements show no evidence for K capture in the decay of 140- and 1300-day ^{174}Lu isomers. On the basis of the present results, the following limits are determined for the energy difference $\Delta = {}^{174m}\text{Lu} - {}^{174g}\text{Lu}$: 149 keV < Δ < 255 keV. Assuming Δ = 171 keV as reported in the literature, the following limits are deduced for the total electron-capture disintegration energies: 1361 keV < $Q_{EC}(^{174g}\text{Lu})$ < 1383 keV; 1532 keV < $Q_{EC}(^{174m}\text{Lu})$ < 1554 keV. That electron capture is not possible in ^{174}Hf decay is confirmed by determining a lower limit of 5×10^{13} for the electron-capture half-life of this nuclide. (auth)

5848 PROPERTIES OF HIGH-LYING LEVELS IN ^{199}Au. Bashandy, E.; El-Sayad, G. M. (Atomic Energy Establishment, Cairo). Z. Naturforsch., 22a: 1538-42(Oct. 1967).

The energy-level spectrum of ^{199}Au excited in the decay of the 30-min activity of ^{199}Pt was investigated by means of a high-resolution, double focusing β-ray spectrometer. The K- and L-conversion ratios of the 196- and 221-keV γ rays show that both are pure E2 transitions. The internal K-conversion coefficients of the 541-, 790- and 960-keV γ rays were determined by the internal-external conversion method, and the following results were obtained: $\alpha_K(541) = 0.059 \pm 0.007$; $\alpha_K(790) = 0.023 \pm 0.003$; $\alpha_K(960) = 0.062 \pm 0.008$. The multipolarity assignments of these transitions were studied on the basis of the conversion coefficients. These data and the studies of other workers were combined to obtain the spins and parities $9/2^+$, $1/2^+$, $3/2^+$, and $9/2^+$ for the 541-, 737-, 790-, and 960-keV levels in ^{199}Au. (auth)

5849 DECAY OF ^{123}Xe, $T_{1/2}$ = 2.08 hr. Gfoeller, D.; Schoeneberg, R.; Flammersfeld, A. (Univ., Gottingen, Ger.). Z. Phys., 208: 299-312(1968). (In German).

^{123}Xe ($T_{1/2}$ = 2.08 hr) was produced by bombarding ^{122}Te with 48-MeV α particles. The radioactive ^{123}Xe gas was collected during irradiation in liquid air cooled glass ampoules. The gamma rays associated with the decay of ^{123}Xe were investigated using Ge(Li) and NaI(Tl) counters and a Ge(Li)-NaI(Tl) coincidence circuit. Fifty-seven gamma transitions in the energy range from 148.7 to 2559.1 keV were found. By depositing the radioactive Xe ions on Ti foils, sources were obtained that were thin enough to study the conversion electrons using a Si(Li) counter. The conversion coefficients for the intensive ^{123}I transitions with low energy were determined. A level scheme for $^{123}\text{Xe} \rightarrow {}^{123}\text{I}$ which accounts for almost all observed γ transitions having 16 levels is proposed. Furthermore, some new data for the ^{121}I and ^{123}I decay are presented. (auth)

5850 MEASUREMENT OF THE LEVEL SCHEME OF ^{141}Pr. Hesse, K.; Wien, K. (Technische Hochschule, Darmstadt). Z. Naturforsch., 22a: 1642-4(Oct. 1967). (In German).

Gamma spectra from the decay of ^{141}Nd were measured. Levels at 1126.8, 1292.8, 1298.5, 1579.8, and 1608.7 keV in ^{141}Pr were identified in addition to the first excited state at 145.4 keV. Possible spin-parity assignments were made for these levels. (D.C.W.)

5851 IDENTIFICATION OF THE T < COMPONENTS FOR SINGLE-PROTON SINGLE-PROTON HOLE STATES IN ^{90}Zr. Vourvopoulos, G.; Fox, J. D. (Florida State Univ., Tallahassee). Phys. Lett., 25B: 543-4(Nov. 13, 1967).

^{89}Y(^{3}He,d)^{90}Zr data taken with the Oak Ridge Isochronous Cyclotron at $E_{^3He}$ = 25 MeV are analyzed. Previously seen states at 0.0, 1.76, 2.32, 2.73 MeV are used for a check on the analysis. Five $l_p = 1$ states are found in the vicinity of 4.5 MeV excitation, and this is plausible only if the ground state of ^{89}Y is not pure $p_{1/2}$. Fourteen $l_p = 2$ states are found between 5.08- to 6.64-MeV excitation, which are considered to be the $T_< = T_z$ single particle-hole states of the $p_{1/2}$-$1d_{5/2}$ proton configuration in ^{90}Zr. (auth)

5852 NEW ANTIMONY DELAYED NEUTRON PRECURSOR. Tomlinson, L.; Hurdus, M. H. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 25B: 545-7(Nov. 13, 1967).

A new antimony delayed neutron precursor with a half-life of 11.3 ± 0.3 sec is reported. On half-life grounds this is assigned to ^{134}Sb. The corresponding delayed neutron emitter (^{134}Te) is the first example of a delayed neutron emitter containing a magic number of neutrons. (auth)

5853 INVESTIGATION OF ^{151}Tb RADIATION. Vil'skii, K.; Kuznetsov, V. V.; Nil'sen, O. B.; Skilbrait, O.; Khalkin, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 672-84(Oct. 1967). (In Russian).

The conversion-electron, gamma, and electron–gamma coincidence spectra in the decay of ^{151}Tb were investigated. Based on the energy balance, gamma ray spectrum, and intensity balance the $^{151}\text{Tb} \rightarrow {}^{151}\text{Gd}$ decay scheme is proposed. The population of levels in ^{151}Gd and log ft values are determined. (auth)

5854 RADIATION ASYMMETRY AND NUCLEAR MAGNETIC RESONANCE OF THE β-RADIOACTIVE NUCLEI PRODUCED BY CAPTURE OF POLARIZED THERMAL NEUTRONS. Gul'ko, A. D.; Trostin, S. S.; Khudoklin, A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 6: 657-71(Oct. 1967). (In Russian).

The radiation asymmetry and the nuclear magnetic resonance of polarized β-radioactive nuclei were investigated. The experimental arrangement is described and the results are presented. The polarized nuclei were produced in the unpolarized target bombarded by polarized thermal neutrons. The apparatus permits one to work at various temperatures of the target, including liquid

helium temperatures. For the nuclei ^{8}Li, ^{20}F, ^{108}Ag, ^{110}Ag, and ^{66}Cu the β-radiation asymmetry is measured and spins of the excited states formed after thermal neutron capture are determined. Polarizations of the ground states of these nuclei are given. The magnetic moments of the ground states of ^{8}Li and ^{20}F are measured. An increase of the β-radiation asymmetry for ^{20}F and a variation of the nuclear magnetic resonance curve for the monocrystal of CaF_2 were observed when the sample temperature falls to the liquid helium level. (auth)

5855 INVESTIGATION OF THE ^{8}Li PRODUCTION ON THE NUCLEI Ag AND Th INDUCED BY THE 660 MeV PROTONS. Grigor'ev, E. I.; Lozhkin, O. V.; Maltsev, V. M.; Yakovlev, Yu. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 696-702(Oct. 1967). (In Russian).

Differential energy spectra and angular distributions of the ^{8}Li fragments emitted from the Ag and Th nuclei bombarded by the 660 MeV protons were investigated. The distributions obtained are compared with the curves calculated in the framework of the statistical model taking into account the properties of the excited nuclei produced at high energy of the incident particles (cascade evaporative model). The results of the analysis show that the whole phenomenon cannot be described as a statistical process. (auth)

5856 PHOTOFISSION OF THE NUCLEI Bi, Pb, Tl, Au, Pt, Os, Re, Ta, AND Hf IN THE ENERGY REGION UP TO 1600 MeV. Mitrofanova, A. V.; Ranyuk, Yu. N.; Sorokin, P. V. Yadern. Fiz., 6: 703-7(Oct. 1967). (In Russian).

Yields of photofission fragments are measured for the nuclei Bi, Pb, Tl, Au, Pt, Os, Re, Ta, and Hf in the photon energy interval from 300 to 1600 MeV. The photofission cross-sections are calculated with the data obtained and are found to be approximately constant in the investigated energy interval. Such a behavior of the photofission cross-sections is shown to be in agreement with the meson mechanism of γ-quanta absorption. The nuclear fissionabilities are obtained as functions of the parameter Z^2/A. (auth)

5857 KINETIC ENERGIES AND FRAGMENT YIELDS FROM FISSION OF ^{233}U AND ^{238}U BY MONOENERGETIC NEUTRONS. Senchenko, V. I.; Sergachev, A. I.; Mikhailov, V. B.; Vorob'eva, V. G.; Tarasko, M. Z.; Kuz'minov, B. D. Yadern. Fiz., 6: 708-13(Oct. 1967). (In Russian).

The kinetic energy and mass distributions of fragments were investigated from the fission of ^{233}U by thermal neutrons and neutrons with energy 0.4 and 2.6 MeV, and at the fission of ^{238}U by the neutrons with energies 2.5 and 7 MeV. The difference in the energy dependence of the fragment yields for ^{233}U and ^{238}U is discussed. From the fission of ^{233}U by the 0.4 MeV neutrons the variations of the yields do not differ qualitatively from the fission with higher excitation energy. Difficulties in the interpretation of the kinetic energy distributions of fragments are noted. The width of the kinetic energy distribution of fragments is established to be 2 MeV larger in the case of ^{238}U as compared with that for ^{233}U. The width does not depend on the excitation energy within the limits studied. (auth)

5858 STATIC QUADRUPOLE MOMENT OF VIBRATIONAL EVEN NUCLEI AND THE COUPLING SCHEME FOR ODD NUCLEI. Kisslinger, Leonard S.; Kumar, Krishna (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 19: 1239-43 (Nov. 20, 1967).

It is observed that an anharmonic treatment of the low-lying collective modes in vibrational and transition regions is consistent with detailed theoretical calculations and with experimental static quadrupole moments and other systematic experimental data in even-even nuclei. The resulting effect on even-odd nuclei is to provide a significant improvement in the coupling scheme. (auth)

5859 BAND MIXING IN ^{152}Sm AND ^{154}Gd. Riedinger, L. L. (Oak Ridge National Lab., Tenn.); Johnson, Noah R.; Hamilton, J. H. Phys. Rev. Lett., 19: 1243-7(Nov. 20, 1967).

The gamma-ray intensities in the decay of ^{152}Eu and ^{154}Eu were measured using a Ge(Li) detector. Coincidence measurements were also made on these nuclei. Reduced E2 transition probabilities from members of the β bands in ^{152}Sm and ^{154}Gd were obtained, as were band mixing parameters. The results were compared with theoretical predictions. (D.C.W.)

5860 GAMMA RAYS FOLLOWING ^{40}Ar-INDUCED REACTIONS. Ward, David; Stephens, F. S.; Newton, J. O. (Univ. of California, Berkeley). Phys. Rev. Lett., 19: 1247-50(Nov. 20, 1967). (UCRL-17537).

Separated Sn and Te isotopes were bombarded with ^{40}Ar projectiles in order to study the (^{40}Ar, xn) reactions and to evaluate them as a means to produce excited nuclei for spectroscopic studies. This proves to be an excellent method for populating groundband collective levels, and such levels were identified in the 88-, 90-, and 92-neutron Er and Yb isotopes. (auth)

5861 EXPERIMENTAL EVIDENCE FOR PARTICLE-VIBRATION COUPLING IN ^{209}Pb. Ellegaard, C.; Kantele, J.; Vedelsby, P. (Univ., Copenhagen). Phys. Lett., 25B: 512-14(Oct. 30, 1967).

Low-lying levels in ^{209}Pb were studied by means of the reaction ^{208}Pb(d,pγ). Delayed (p,γ) coincidence measurements yield the half-life of the 1422 keV level, $\tau_{\frac{1}{2}} = 1.36 \pm 0.30$ ns, and an upper limit for the half-life of the 778 keV level, $\tau_{\frac{1}{2}} < 1.0$ ns. From these it is concluded that the 778 and 1422 keV levels in ^{209}Pb correspond to the $i_{13/2}$ and $j_{15/2}$ shell-model states, respectively. The speed of the depopulating E3 transition from the $j_{15/2}$ level is about 16 single-particle units. This enhancement is taken as evidence for coupling to the collective vibration of ^{208}Pb. (auth)

5862 THE K-CONVERSION COEFFICIENT OF THE 569.6 keV TRANSITION IN ^{207}Pb. Van Nooijen, B.; Van Krugten, H. (Technische Hogeschool, Delft, Netherlands). Phys. Lett., 25B: 510-11(Oct. 30, 1967).

To measure the K-conversion coefficient of the 569.6 keV transition in ^{207}Pb, ^{207}Bi (which decays to ^{207}Pb by electron capture) was mixed with ^{137}Cs. The 661.6 keV transition in the decay of ^{137}Cs served as a reference line. The intensity I_γ of the 569.6 keV γ ray in ^{207}Bi relative to the intensity of the 661.6 keV γ ray of ^{137}Cs and the intensity I_K of the 569.6 keV K-conversion line relative to the intensity of the 661.6 keV K-conversion line of ^{137}Cs were measured. Then, using the known value of the K-conversion coefficient α_K (Cs) of the 661.6 keV transition in ^{137}Cs, the K-conversion coefficient α_K (Bi) of the 569.6 keV transition in ^{207}Bi was calculated from α_K (Bi) = $(I_K/I_\gamma)\alpha_K$(Cs). A result of $\alpha_K = 0.0159 \pm 0.0006$ was obtained. (S.F.L.)

5863 THE MEASUREMENT OF INTERNAL CONVERSION COEFFICIENTS UTILIZING SEMICONDUCTOR DETECTORS. DECAY SCHEME STUDIES OF THE ODD-MASS GOLD ISOTOPES. Haverfield, Arthur Judd. Berkeley, Calif., Univ. of California, 1966. 195p.

Thesis.

The application of semiconductor detectors to measurements of internal conversion coefficients is extensively discussed, with particular emphasis being placed upon a spectrometer employing both Si(Li) and Ge(Li) detectors for the simultaneous observation of conversion electrons and gamma rays. The construction, calibration, and use of such a spectrometer are described. Possible improvements in this system are also discussed. It was found that this type of spectrometer is best suited for ICC measurements of transitions following electron-capture decay, but may still be useful in cases of beta or positron decay. The level schemes of the odd-mass Au isotopes of mass 199, 197, 195, and 193 were examined from the decay of the respective odd-mass Pt and Hg isotopes. The measurement of numerous internal conversion coefficients permitted the assignment of spin and parity values to many of these levels. The systematic trends of many of the nuclear phenomena associated with these isotopes were examined as a function of neutron number. The experimental data were compared to the various theoretical approaches applicable to this region of nuclei. The internal conversion process was discussed along with the various experimental methods of ICC measurement. The calibration of semiconductor detectors for energy and intensity measurements was discussed. Extensive tables of standards for these calibration procedures are presented. (Disser. Abstr.)

5864 THE MAGNETIC MOMENT OF ^{239}Pu. Faust, John Daly. Berkeley, Calif., Univ. of California, 1966. 64p.

Thesis.

The triple-loop technique of atomic-beam magnetic resonance was used to determine the magnetic moment of ^{239}Pu directly. The final measurement was carried out at a magnetic field of 720 gauss and the magnetic moment was found to be $\mu_I = +0.200(4)$ nm (corrected), where the sign is measured to be positive. Hyperfine-structure measurements on ^{241}Pu, ^{185}W, and ^{187}W were attempted. These experiments involved the observation of four- and six-quantum transitions because of the inverted level ordering which was caused by the unusually large values of the quadrupole moments of all of these isotopes. (Disser. Abstr.)

5865 THE ^{208}Pb(d,p)^{209}Pb REACTION WITH 15 TO 25 MeV DEUTERONS. Poltorak, Andrew Stephen. Ann Arbor, Mich., Univ. of Michigan, 1966. 80p.

Thesis.

The purpose of this study was to measure differential cross sections from the ^{208}Pb(d,p)^{209}Pb reaction for the seven low lying energy levels in ^{209}Pb and to determine the best set of parameters and conditions for the distorted wave approximation (DWA)

analysis of these cross sections. The DWA formulation used was the computer code Julie, run at Oak Ridge National Laboratory. Deuterons with energies of 14.8, 20.1 and 24.8 MeV, obtained from the University of Michigan 83-inch sector-focused cyclotron and its associated magnetic beam preparation system, were used for the measurements. The protons were analyzed in momentum with the magnetic reaction products analysis system at the facility and detected either with nuclear emulsions or a sonic spark chamber. The determination of the best set of parameters and conditions for the DWA analysis was done to obtain a calibration and an evaluation of the DWA for heavy nuclei. Since the target nucleus, ^{208}Pb, is a doubly closed shell nucleus, the seven levels in ^{209}Pb should correspond to pure single particle states, each with a single orbital angular momentum, l-value, and spectroscopic factor of unity. With these expected values a calibration of the analysis is possible. The measurements and analysis made have located and identified the seven expected levels in ^{209}Pb. The Q-values of the levels, determined to within ±10 keV, and the l-values, determined by comparison of the DWA predictions with the measured angular distributions, are both in agreement with earlier measurements. Since no dependence on total angular momentum was found in either the measured or predicted cross sections, the assignment was made on the basis of shell model considerations. To obtain spectroscopic factors closest to the expected values of unity from the DWA analysis, only the approximations of the range of the interaction, the locality of the potentials representing the nuclei and the lower integration limit of the transition amplitude were varied in the analysis. Predictions were obtained for zero range interactions, local potentials; finite range interaction, non-local distorted wave potentials; and finite range interaction and non-local distorted wave and bound state neutron potentials; all with lower radii of integration of 0, 6, and 8 fermis. The finite range interaction and non-local potentials were accounted for through the local energy approximation. The conditions giving the best fit to the measured differential cross sections for all seven levels at the three energies were finite range interaction, non-local distorted wave potentials with lower integration radius of zero. The spectroscopic factors obtained had a range of ±40% from unity. Using the best conditions as standard, the other two conditions gave results with lower spectroscopic factors, but essentially the same shape of the angular distributions, for the same lower integration radius. The effect of varying the lower integration radius was random in both the shape and magnitude of the predicted cross sections. Since the results of the conditions used were so varied, no parameter changes were tried. Only partial success was obtained in the calibration of the DWA in the mass and energy region studied; while l-values can be obtained reliably, spectroscopic factors can be extracted only to about ±40%. Therefore the distorted wave analysis in its present form is not the ideal tool for obtaining spectroscopic factors for energy levels by means of (d,p) reactions on heavy elements. Nevertheless, it still is a valuable method and will provide useful spectroscopic information for other heavy nuclei. (auth)

Nuclear Theory

Refer also to abstracts 5152, 5423, 5526, 5618, 5666, 5758, 5768, 5799, 5809, 5820, 5827, 5856, 5858, and 6177.

5866 (BNL-11884) HYPERFINE STRUCTURE IN A FLUCTUATING ENVIRONMENT. Blume, M. (Brookhaven National Lab., Upton, N. Y.). Aug. 1967. 32p. (CONF-670812-16). Dep. CFSTI.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif.

The theory of hyperfine structure in the presence of time-dependent electronic fluctuations (such as those induced by electron spin relaxation) is considered. A general expression applicable to the Moessbauer line shape, perturbed angular correlations, angular correlation NMR, and resonance in oriented nuclei is derived. A number of realistic, exactly soluble stochastic models for relaxation phenomena are presented and are compared with perturbation-theoretic treatments such as those of Abragam and Pound and Bradford and Marshall. The theory is applied to the calculation of the Moessbauer line shape and also to the calculation of angular correlations of successive nuclear decays. (auth)

5867 (CEA-R-3260) MESURES ABSOLUES D'ACTIVITE NUCLEAIRE PAR LA METHODE DES COINCIDENCES $\gamma-\gamma$. (Absolute Nuclear Activity Measurements Using the $\gamma-\gamma$ Coincidence Method). Benoit, Paulette; Philis, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1967. 54p. (In French). Dep.

A summary is first given of the principle of the $\gamma-\gamma$ calibration method, with emphasis on the corrections required. After a description of the equipment used, the choice of the experimental conditions required for various isotopes (^{22}Na, ^{46}Sc, ^{60}Co, ^{88}Y) is discussed, and the agreement between these results and those obtained by other absolute measurement methods is considered. (auth)

5868 (INP-566/PL) SUM RULES FOR INELASTIC ELECTRON SCATTERING. Czyz, W. (Institute of Nuclear Research, Krakow (Poland)). 1967. 26p. Dep.

Various sum rules for inelastic electron scattering from nuclei are discussed together with some applications. (auth)

5869 (LA-3753) PHOTON CROSS SECTIONS FROM 0.001 TO 100 MeV FOR ELEMENTS 1 THROUGH 100. Storm, Ellery; Israel, Harvey I. (Los Alamos Scientific Lab., N. Mex.). June 1967. Contract W-7405-eng-36. 257p. Dep. CFSTI.

Tables are given of photon cross sections in the range 0.001 to 100 MeV for Z = 1 to 100. Supplementary tables of mass attenuation coefficients for air, water, concrete, and sodium iodide; x-ray atomic energy levels; line energies; average energies; relative intensities; and fluorescence yields are also presented. (auth)

5870 (ORNL-4179) A FORTRAN PROGRAM FOR RELATIVISTIC KINEMATIC CALCULATIONS IN TWO-BODY NUCLEAR REACTIONS. Phillips, R. E.; Thornton, S. T. (Oak Ridge National Lab., Tenn.). Nov. 1967. Contract W-7405-eng-26. 25p. Dep. CFSTI.

A computer program was developed for calculating the kinematics of two-body nuclear reactions using relativistic formulas. The energies and scattering angles of the two decay particles in the laboratory system and the energies of all four particles in the center-of-mass system, along with the center-of-mass to laboratory differential cross-section ratio are calculated. The input consists of the four masses, the Q-value, the laboratory scattering angle, and the initial laboratory bombarding energy. The program exists for both the Control Data 1604-A and IBM System/360 Model 75 computers in both regular and double precision FORTRAN. (auth)

5871 (UJV-1870) DEUTERON STRIPPING AND PICK UP REACTIONS. Kroha, V.; Piskor, S. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Aug. 1967. 88p. Dep.

The dynamics of the (d,p) reaction is discussed with primary consideration of the reliability of the theory of this reaction. The shape and magnitude of the effective differential cross section of the reaction are studied; comparisons are made with experimental data. Spectroscopic applications of direct reactions are then discussed from the viewpoint of different models for nuclear structure. 86 references. (D.C.W.)

5872 GROUND-STATE THREE-BODY CORRELATION FUNCTION IN A DILUTE BOSON GAS WITH HARD-SPHERE INTERACTION. Bocchieri, P. (Univ., Parma, Italy. Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy); Orzalesi, C. A.; Smith, V. H. Jr. Nuovo Cim. (10), 52B: 18-27(Nov. 11, 1967).

The ground-state three-body correlation function for a hard-sphere boson gas is evaluated first with the Lee, Huang and Yang wave function by means of a cluster expansion and then with the exact two-body pseudopotential of Luban. The results obtained are compared with a previous calculation and are discussed chiefly with regard to the influence of the two-body pseudopotential on the wave function of the system. It is found, in particular, that a modification of the pseudo-potential within the hard core gives significant modification of the wave function. (auth)

5873 DIRECT PHOTONUCLEONS FROM ODD NUCLEI AND COUPLING OF SINGLE NUCLEONS TO COLLECTIVE CORE EXCITATIONS: REACTION ^{9}Be(γ,n)^{8}Be. II. Boffi, S. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy); Pacati, F. D.; Sawicki, J. Nuovo Cim. (10), 52B: 210-19(Nov. 11, 1967).

A model of an odd-A nucleus is considered in which the single-particle states of the valence nucleon are vector-coupled to rotational excitations of the core. The model is applied to calculate the differential and total cross sections and the transverse polarization of the outgoing valence nucleon for the direct photonuclear reaction at low energy. The transitions considered are E1, E2 and M1. The reaction ^{9}Be(γ,n)^{8}Be is discussed from this point of view. The related simple model proposed by Kowalska is discussed and criticized. (auth)

5874 ANALYSIS OF NUCLEAR REACTIONS WITH THE ^{28}Si AS INTERMEDIATE SYSTEM. Corleo, G.; Pappalardo, G.; Rubbino, A. (Univ., Catania, Italy. Istituto Nazionale di Fisica Nucleare, Catania, Italy). Nuovo Cim. (10), 52B: 248-50(Nov. 11, 1967).

The quantity D_0 which appears in the statistical expression for the integrated cross sections of reactions in the continuum region and which is related to the average spacing D_J of the compound-nucleus levels of spin J through $D_0 = D_J\,(2J + 1)$ was evaluated by

putting data obtained by fluctuation analysis of reactions with ^{29}Si intermediate states into the cross-section expression. (D.C.W.)

5875 OBSERVATION OF MOESSBAUER EFFECTS IN THE DECAY OF COULOMB EXCITED NUCLEAR LEVELS. Walker, J. C.; Lee, Y. K. (Johns Hopkins Univ., Baltimore). pp 179-89 of Moessbauer Effect Methodology. Vol. 3. Gruvermann, Irwin J. (ed.). New York, Plenum Press, 1967.

From 3rd Annual Moessbauer Symposium, New York, Jan. 29, 1967. See CONF-670110-(Vol.3).

The techniques of Moessbauer spectroscopy using Coulomb-excited nuclear levels are discussed. Primary emphasis is on new Moessbauer levels in the rare-earth region, and on the experimental techniques used to provide cooled targets and absorbers in order to see Moessbauer effects of reasonable size. The problem of radiation damage in the target is discussed, and some conjectures are advanced to explain the absence of appreciable distortions in the resulting Moessbauer hyperfine spectra. Results of a study of the even isotopes of ytterbium are presented as an example of the use of the above techniques in studying nuclear systematics. The Moessbauer-effect results for the quadrupole moments of the first excited states of these isotopes are compared with previous values obtained by using the collective model and measured Coulomb-excitation cross sections. (auth)

5876 LEVEL DENSITY OF NUCLEI. Neugebauer, Th. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung., 23: 95-110(1967). (In Hungarian).

A brief discussion is given of the question of why the elementary power laws operating between two nuclei are still not always known and how far the lack of excited levels in the lattice nuclei is responsible for this. A purely classical description is given of the problem of to what extent in the potential laws occurring in the nuclear physics the energy must be negative. With the use of the Bohr theory a calculation was made of the quantum state in these ranges. These results were considered from the viewpoint of quantum mechanics. It was shown that when there is interaction of many nucleons, the range in which the energy is negative must be increased greatly and the quantum conditions are altered only slightly. The origin of this effect is that the potential energy must be added as scalar and the force as vectoral forces. This fact explains the occurrence of complicated term schemes in heavy nucleons and also those phenomena which are partially analogous to those occurring in the electron shell. (tr-auth)

5877 BETHE–SALPETER EQUATION AND CONSERVATION LAWS IN NUCLEAR PHYSICS. Brenig, W. (Max Planck Inst. for Physics, Munich). pp 99-105 of Symposia on Theoretical Physics. Vol. 3. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

It is shown that invariances such as gage invariance, Galilean invariance, or the corresponding conservation laws following from them lead to many relations among the rather large number of free parameters arising from the application of Bethe–Salpeter techniques. In this way the number of these independent parameters is considerably reduced. (J.F.P.)

5878 STRENGTH OF THE REPULSIVE INTERACTION IN ATOMIC NUCLEUS. Khanna, K. M.; Bhattacharya, P. (Indian Inst. of Tech., Kharagpur). Indian J. Pure Appl. Phys., 5: 253-6(July 1967).

Using the Green's function method, the strength of the average repulsive potential between nucleons in an atomic nucleus was calculated in units of the attractive potential over the range $\gamma_c \leq \gamma \leq 1/\mu$, between 0.4 f and 2.0 f, where f is one Fermi. The repulsive potential is determined in terms of the undetermined function $K_l(a)$ when $l = 0$, and a is arbitrary and is approximately equal to the reciprocal of the healing distance. For various values of a, the corresponding values for $K_0(a)$ were calculated, and it is found that as the value of a increases, the value of $K_0(a)$ increases. A plot was made of $K_0(a)$ against a, and from the intersection of the graph on the a-axis, the value of a is obtained which in turn gives the value of the healing distance, for which the repulsion between the nucleons is very small or approximately zero. (auth)

5879 STATISTICAL MECHANICS OF A SUPERFLUID NUCLEAR MATTER. Khanna, K. M. (Indian Inst. of Tech., Kharagpur). Indian J. Pure Appl. Phys., 5: 257-60(July 1967).

The superfluidity of a nuclear system consisting of an equal even number of protons and neutrons was studied assuming that, in the superfluid state, the nuclear matter is composed of non-interacting α-particles. Hence for such a system Bose statistics is appropriate. The basic interaction between nucleons was assumed to be of the same type as that of the experimentally fitted two-body potential proposed by J. L. Gammel and R. M. Thaler [Phys. Rev., 107: 291(1957)]. The critical temperature of transition T_c of such a nuclear system was calculated for different values of the nuclear density (ρ) in particles/cm^3. The value of T_c increases as ρ increases, and the graph of T_c versus ρ is more or less a straight line indicating thereby that the nucleons continue to move according to the usual laws of motion prevalent in the nuclear matter even when it is further compressed. The straight line type of graph of T_c versus ρ also indicates that nuclear matter is highly compressed. A finite latent heat of transition shows that it is a first order phase transition. (auth)

5880 PAIRING APPROXIMATION IN SPHERICAL NUCLEI. II. Bleuler, K. (Univ., Bonn); Beiner, M.; de Tourreil, R. Nuovo Cim. (10), 52B: 149-86(Nov. 11, 1967).

The numerical calculations of separation energies and quasi-particle excitations for spherical nuclei ($A > 20$) are given in some detail. The method (described in part I) consists of a reduced Hartree-Bogolyubov scheme with a realistic (effective) two-body interaction and a phenomenological nuclear potential. The relevant numerical values which occur in the computations (single-particle energies, reduced matrix elements and the gap matrices) are tabulated. In addition, the characteristic occupation probabilities v_j^2 of pairs over the various subshells are plotted as functions of the nucleon numbers. The low-lying quasi-particle states of odd nuclei were determined throughout the periodic table for all "isotopes" on an "ideal" middle line. Within the lower spherical region the complete set of levels is plotted in a graphical survey There is a fairly good agreement with the corresponding empirical data within a relatively large interval ($28 < A < 90$). (auth)

5881 PAIRING APPROXIMATION IN SPHERICAL NUCLEI. I. Bleuler, K. (Univ., Bonn); Beiner, M.; de Tourreil, R. Nuovo Cim. (10), 52B: 45-62(Nov. 11, 1967).

The pairing theory (BCS method) is applied to spherical nuclei in order to calculate some characteristic physical properties. The main points are: insertion of an effective (realistic) two-nucleon force in the pairing matrix elements, and definition of a phenomenological nuclear potential in order to determine the single-particle states. The effective two-nucleon interaction was obtained from the Hamada–Johnston expression by means of a Scott–Moszkowski procedure; the complete set of nuclear potentials (of Saxon–Woods type) contains 5 constants which were determined from specific nuclear properties (empirical determination of the self-consistent field occurring in a Hartree–Bogolyubov treatment). The gap equation was solved numerically taking into account all relevant single-particle states. The final results (separation energies and quasi-particle excitations) as well as the corresponding empirical data are plotted simultaneously as functions of the nucleon numbers. There is a satisfactory agreement just within the spherical regions; in particular the correspondence between the typical irregularities at the magic numbers and between the characteristic variations of the quasi-particle levels and of the pairing energies should be emphasized. (auth)

5882 NEUTRON PAIRING ENERGIES. Banerjee, D. (Palit Lab. of Physics, Calcutta). Nuovo Cim. (10), 52B: 233-5(Nov. 11, 1967).

The variations of neutron pairing energy (P_n) with the total angular momentum (J), neutron and proton numbers, and mass number (A) were investigated. The pairing energies for $A > 50$ were fitted by the expression $P_n = -(20/A^{0.5} + 16J/A)$. (D.C.W.)

5883 THEORY OF GAMMA-RAY CROSS SECTIONS. Pratt, R. H. (Univ. of Pittsburgh). Trans. Amer. Nucl. Soc., 10: 523(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5884 CALCULATION OF NEUTRON-CAPTURE GAMMA-RAY SPECTRA. Yost, K. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 522-3(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5885 PAIR CONVERSION IN E0 TRANSITIONS. Begzhanov, R. B.; Belen'kii, V. M.; Rakovitskii, S. L. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 41-53(1967). (In Russian).

Pair-conversion for E0 transitions was calculated for all even-Z nuclei in a wide range of energies. The probabilities of pair production in E0 conversions are tabulated. Comparisons of the theoretical and experimental data on the probabilities of electron and pair conversions in the ^{16}O, ^{40}Ca, ^{42}Ca, ^{90}Zr, ^{140}Ce, and ^{214}Po nuclei showed that the calculations are in good agreement with published experimental data. (R.V.J.)

5886 DENSITY MATRIX IN THE TWO-PARTICLE FUNCTION METHOD. Mestechkin, M. M. (Physical-Technical Inst., Donetsk, USSR). Int. J. Quant. Chem., 1: 675-92(Sept. 1967).

The first- and second-order density matrices $D^{(N)}$ and $D_2^{(N)}$ for the function $g^{(a)} = A_N[g(1,2) \ldots g(N-1,N)]$ were expressed by the g function itself and its density matrix D. In a singlet state the generating functions for spatial parts of these matrices were simply related to the solutions of the Fredholm equation in which the spatial part of D is a nucleus. Some special cases of g(1,2) were considered. It was established that the number of large eigenvalues of $D_2^{(N)}$ does not exceed that of different eigenvalues of D. Thus the degeneracy in the spectrum of D causes the appearance of such large eigenvalues. (BBB)

5887 ft VALUES OF SUPERALLOWED 0-0 TRANSITIONS. **Behrens, H. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.); Buehring, W. Nucl. Phys., A196: 433-41(1967).**

The ft values for some superallowed 0^+-0^+ transitions are calculated. The influence of second-forbidden and finite nuclear size terms is discussed. A slightly modified definition of the ft value is recommended, which is more suitable for comparing different nuclei. (auth)

5888 INELASTIC ELECTRON SCATTERING CROSS SECTIONS USING A FINITE NUCLEAR WELL. **Holder, F. D.; Eisenberg, J. M. (Univ. of Virginia, Charlottesville). Nucl. Phys., A106: 261-74(1967).**

Theoretical studies of the electroexcitation of light were carried out using a Woods-Saxon potential with spin-orbit coupling as an approximation to the nuclear self-consistent field. These calculations are expected to yield more realistic results at high momentum transfer than those given by conventional harmonic oscillator wave functions. A finite-range residual interaction was used with the Woods-Saxon potential in the particle-hole formalism to generate consistent wave functions for the excited states of closed shell or closed subshell nuclei. These were then used to calculate inelastic electron scattering form factors based on the Born approximation. Particular attention was given to the lowest octupole excitation of ^{16}O, to the magnetic dipole state in ^{12}C at 15.1 MeV, and to the giant resonance levels of both these nuclei. Comparison was made with the results of calculations performed using a harmonic oscillator potential and with experiment. (auth)

5889 ORTHOGONALITY AND COMPLETENESS OF THE ROTATION MATRICES. **Jonker, J. E.; De Vries, E. (Univ. of Groningen, Netherlands). Nucl. Phys., A105: 621-6(1967).**

In order to make the region of the Euler angles large enough to ensure orthogonality and small enough to ensure completeness for the set of functions $D^j_{m'm}(\alpha,\beta,\gamma)$, one may take, e.g., $0 \leq \frac{1}{2}(\alpha + \gamma) \leq 2\pi$, $-\pi \leq \frac{1}{2}(\alpha - \gamma) \leq \pi$ and $0 \leq \beta \leq \pi$. Allowing for the periodicity in the directions of the $\alpha + \gamma$ and $\alpha - \gamma$ axes, the region may be cast in many different shapes. (auth)

5890 HARTREE-FOCK FIELDS FOR NUCLEI IN THE s-d SHELL. **Stamp, A. P. (Univ. of Auckland, New Zealand). Nucl. Phys., A105: 627-39(1967).**

Results are reported for Hartree-Fock calculations using the revised effective t-matrix elements for the Yale, two-nucleon potential. The doubly even nuclei in the s-d shell are considered. No restrictions are made to the shape of the nucleus. The form of the energy surface in the $\beta\gamma$-plane is in agreement with the earlier results. However, there is an overall reduction in the binding energy per particle of approximately 1.5 MeV. The rotation of deformed solutions is discussed together with the evidence for moments Y_4^4 in the shape of the nuclear surface. The Hartree-Fock solutions are used in the evaluation of the moment of inertia. It is shown that the contributions of the $2\hbar\omega$ particle-hole configurations to the moment of inertia are negligible. (auth)

5891 FERMI FUNCTIONS FOR SUPERALLOWED BETA DECAYS AND THE VALUE OF G_V. **Blin-Stoyle, R. J.; Nair, S. C. K. (Univ. of Sussex, Eng.). Nucl. Phys., A105: 640-8 (1967).**

To extract the polar vector beta-decay coupling constant G_V from the data on $0^+ \rightarrow 0^+$ superallowed transitions, accurate values of the Fermi function are needed. The details and the results of a numerical evaluation of the relevant Fermi functions are reported. Both the finite size charge distribution of the nucleus and the screening effect due to the atomic electrons are taken into account. The G_V (or alternatively the ft values) calculated with these Fermi functions agree very well with earlier results for ^{10}C, ^{14}O, ^{26m}Al, and ^{34}Cl but not for ^{42}Sc, ^{46}V, ^{50}Mn, and ^{54}Co. The probable reason for the disagreement is given, and the implications of the results are discussed. (auth)

5892 ON THE SYMMETRIC S- AND D-STATE COMPONENTS OF THE TRITON WAVE FUNCTION. **McMillan, Malcolm; Best, Melvyn (Univ. of British Columbia, Vancouver). Nucl. Phys., A105: 649-64(1967).**

Approximate forms for the symmetric S- and D-state components of the triton wave function are found using the Feshbach-Rubinow equivalent two-body method. Two coupled ordinary differential equations for the components are obtained, and are solved numerically with the Feshbach-Pease potentials. A further approximation involving one vibrational parameter is shown to yield good results. Appendices contain the Feshbach-Pease variational wave function written in Derrick-Blatt and Sachs notations, and the detailed relations between the Derrick-Blatt and Sachs basis functions. (auth)

5893 THEORY OF ISOBARIC ANALOG RESONANCES. **Lipperheide, R. (Hahn-Meitner Institut fuer Kernforschung, Berlin. Sektor Kernphysik, Berlin). Nucl. Phys., A105: 545-68(1967).**

A theory of isobaric analog resonances on the basis of the many-body problem is proposed. The generalized Pauli principle is taken into account rigorously. A unified description of all effects connected with the isobaric analog resonances is made possible through the introduction of a generalized optical-model potential. (auth)

5894 ISOSPIN DEPENDENCE OF THE NUCLEAR OPTICAL POTENTIAL. **Erramuspe, H. J. (Comision Nacional de Energia Atomica, Buenos Aires). Nucl. Phys., A105: 569-89(1967).**

The isospin-dependent term in the optical-model potential is investigated by comparing results obtained from simultaneous fitting of neutron and proton elastic scattering data from ^{59}Co and ^{209}Bi at an energy approximately equal to 14.4 MeV. The coefficient of the nuclear symmetry parameter term is equal to 23.8 ± 3 MeV if the fits were obtained by keeping fixed the imaginary part of the potential. If this part is allowed to vary and only the best fits are taken into consideration $C = 22.8 \pm 4$ MeV. (auth)

5895 DWBA IN THE SHELL-MODEL APPROACH TO NUCLEAR REACTIONS. **Huefner, J.; Mahaux, C.; Weidenmueller, H. A. (Univ., Heidelberg). Nucl. Phys., A105: 489-521(1967).**

The scattering matrix S is decomposed into two parts, the compound nucleus part and the direct interaction part S(DI). The compound nucleus part S(CN) has uncorrelated partial width amplitudes, so that its energy average has vanishing non-diagonal matrix elements. The direct interaction part is defined as the difference S – S(CN). The decomposition is carried out, in the shell-model approach to nuclear reactions, by a suitable decomposition of the residual interaction, which bears close analogy to the separation proposed recently by Austern and Ratcliff in the frame of a simple model. Under proper statistical assumptions, it is shown that the energy average of S(DI) can often be calculated in first-order perturbation theory and is then given by the familiar DWBA term, if the channels are weakly coupled. The conditions for convergence of the Born series are investigated. The wave functions entering into the DWBA expressions are defined by optical-model potentials. The potentials are derived, and some of their properties are discussed. It is shown that they are equal to the conventionally defined, phenomenological optical-model potentials inasmuch as they reproduce the energy average of the elastic scattering phase shifts. The modifications of the DWBA due to a giant or micrograint resonance or to strong coupling between some channels are given. The analysis of experimental data is discussed for the case when both compound and direct processes contribute to the cross section. The connection between the present work and the approaches used by other authors is exhibited and discussed. (auth)

5896 EFFECT OF EXCHANGE AND THE PAULI PRINCIPLE ON NUCLEON–NUCLEUS SCATTERING. II. **Friedman, William A. (Univ. of Copenhagen). Ann. Phys. (N. Y.), 45: 265-313(1967).**

The exchange operator $1/(1 - K)$, introduced in an earlier paper, is discussed. To this end, the eigenproblem for the K-matrix is examined, and examples are given. The role of the exchange operator is interpreted in the context of exchange scattering and the Pauli principle with emphasis placed on the treatment of spurious levels arising from these effects. An effective Schrödinger equation for open-channel amplitudes alone is constructed from a truncated set of coupled equations, and the components of the Hamiltonian in this equation are examined and are illustrated. Two calculations are discussed, one applying the formal treatment of this and the earlier paper to a shell-model-type calculation of $n-^{16}O$ elastic scattering, the second treating the same problem but omitting certain exchange corrections. The results of the two calculations are compared. (auth)

5897 RADIATIVE-CAPTURE STUDIES OF THE GIANT DIPOLE RESONANCE. **Segel, Ralph E. (Argonne National Lab., Ill. Northwestern Univ., Evanston, Ill.). Science, 158: 723-30(Nov. 10, 1967).**

Some inverse experiments on the giant dipole resonance are

described. Experimental data on the angular distributions and yields of gamma rays from (α,γ) and (p,γ) reactions are discussed, together with the theoretical interpretation of the data. (D.C.W.)

5898 INDUCED PSEUDOSCALAR FORM FACTOR IN MUON CAPTURE. Kuhnelt, H. (Univ., Graz). Acta Phys. Austr., 25: 233-8(1967).

A calculation of the induced pseudoscalar form factor in muon capture is made by use of current algebra and the partially conserved axial vector current (PCAC) hypothesis. (S.F.L.)

5899 PARTIAL WIDTHS OF RADIATIVE TRANSITIONS IN HEATED NUCLEI. Kuklin, R. N. Yadern. Fiz., 6: 716-21(Oct. 1967). (In Russian).

Mean widths of radiative transitions from the "heated" state into the rotational states and into the basic state are considered. The widths were averaged over the microcanonical ensemble in the initial state. The excitation energy and atomic number dependence of the mean width of the transition into the basic state differs negligible from the semiempiric Axel formula. The ratio of the transition intensities for the transitions to various rotational levels and the relative intensity of the γ transitions into the basic state are calculated. (auth)

5900 SPIN-ORBITAL INTERACTION IN THE NUCLEUS WITH LARGE MOMENTUM. Pik-Pichak, G. A. Yadern. Fiz., 6: 722-31(Oct. 1967). (In Russian).

The expression for the spin-orbital potential in a nucleus with large momentum is obtained. Besides the usual spin-orbital potential of the shell model there appears an additional term connected with the interaction of the nucleon spin with the total nucleus momentum. This interaction leads to the splitting of one-particle energetic levels of nucleus in momentum projection and changes the value of the main spin polarization of the nucleon in the nucleus. (auth)

5901 ON EXCITED STATES OF THE ^{4}He NUCLEUS. Vashakidze, I. Sh.; Mamasakhlisov, V. I. (Tbilisi State Univ., USSR). Yadern. Fiz., 6: 732-49(Oct. 1967). (In Russian).

Excited levels of the ^{4}He nucleus are investigated assuming that the residual interaction shifting the level due to the average field is a particle-hole interaction. (auth)

5902 MAJORANA EXCHANGE FORCES AND THE PHOTODISINTEGRATION ON THREE-PARTICLE NUCLEI. Dzhibuti, R. I. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz., 6: 750-2(Oct. 1967). (In Russian).

The existence of the term due to the Majorana exchange forces in the Hamiltonian describing the interaction of the radiation with the nucleus is assumed, besides the conventional term $(ih/Mc)\Sigma_k e_k(V_k u)$ in calculations of the dipole matrix elements for the photodisintegration using the variational wave functions that are more precise at small internucleon distances. The theory of photodisintegration for three-particle nuclei based on a Hamiltonian of such a form is shown to agree with the experimental data qualitatively as well as quantitatively. (auth)

5903 SIMPLE QUASICLASSICAL RELATION FOR THE ANGULAR ANISOTROPY IN NEUTRON FISSION OF NUCLEI. Nesterov, V. G.; Simirenkin, G. N.; Tishin, A. S. Yadern. Fiz., 6: 761-4(Oct. 1967). (In Russian).

The discrepancy between the quantum mechanical calculations of the angular anisotropy of the fission and the known quasiclassical formula by Halpern and Strutinsky $A = 5E_n/8K_0^2$ is analyzed. A simple semiempirical relation for the mean square of the nuclear angular momentum is presented that removes this discrepancy. (auth)

5904 DEPENDENCE OF NEUTRON AND FISSION WIDTHS ON THE COMPOUND NUCLEUS SPIN IN THE INTERACTION OF ^{235}U WITH NEUTRONS. Vorotnikov, P. E. Yadern. Fiz., 6: 765-8(Oct. 1967). (In Russian).

A definite correlation between Γ_f, $g\Gamma_n^0$, and the degree of asymmetry of the mass distributions of the fragments for certain resonances in slow neutron fission cross section is noted. All resonances can be divided into two groups corresponding to the different values of the total momentum of the nucleus undergoing fission. Strength function for two mutual orientations of spins of incident neutron and target nucleus differ by a factor ~5. (auth)

5905 NEUTRON RADIATIVE CAPTURE IN THE SYNTHESIS OF HEAVY ELEMENTS IN STARS. Shorin, V. S.; Kapchigashev, S. P.; Kolesov, V. E. Yadern. Fiz., 6: 769-74(Oct. 1967). (In Russian).

The quantities $N_s\sigma_{n\gamma}$ (N_s = abundance of heavy elements, and $\sigma_{n\gamma}$ = the neutron capture cross section) for the nuclei produced in the pure s process are obtained on the basis of new experimental data on the neutron radiative capture cross sections for the separated isotopes and the cross sections calculated by the statistical theory of nuclear reactions, as well as with the data on the chemical contents of meteorites. The results confirm the smooth atomic weight dependence of $N_s\sigma_{n\gamma}$, and are found to be a factor of 2 or 3 lower than it was supposed before. The contributions from the s and r processes on the absolute abundance of the nuclei produced in the mixed capture chain are distinguished. (auth)

5906 SOME NEW SCHEMES FOR POLARIZING NUCLEI. Jeffries, C. D. (Univ. of California, Berkeley). Phys. Rev. Lett., 19: 1221-4(Nov. 20, 1967). (UCB-34-P-20-132).

Some recently proposed techniques for the enhancement of nuclear polarization by optical pumping in solids are discussed in some detail. The extension of these techniques to liquids is also briefly considered. (D.C.W.)

5907 SINGLE-PARTICLE STATES OF THE MEAN FIELD OF DEFORMED NUCLEI. Gareev, F. A.; Ivanova, S. I.; Kalinkin, B. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., 32: 461-77(1967). (In Russian).

A method for solving the Schroedinger equation with a scattering potential is outlined. The method permits calculations of energy and analytic single-particle wave functions of deformed axially symmetric nuclei. (tr-auth)

5908 COMPARISON OF PROJECTED BCS SOLUTIONS WITH EXACT ONES FOR CHARGE-INDEPENDENT ($J = 0$, $T = 1$) PAIRING INTERACTION. Kissener, H. R.; Muenchow, L. (Central Inst. for Nuclear Research, Rossendorf, Ger.). Phys. Lett., 25B: 493-6(Oct. 30, 1967).

Results for neutron-proton pairing are generalized to the case of several non-degenerate j-levels. (auth)

5909 THREE-PARTICLE KNOCK-OUT REACTIONS WITH POLARIZED TARGETS. Kolybasov, V. M.; Shapiro, I. S. (Inst. of Theoretical and Experimental Physics, Moscow). Phys. Lett., 25B: 497-8(Oct. 30, 1967).

A method to determine spins of residual nuclei produced in A(x,yz)B reactions is considered. The method is based on the use of a polarized target. (auth)

5910 RELATION BETWEEN LIPPMANN-SCHWINGER AND BLOCH SCATTERING THEORIES. Robson, B. A. (Australian National Univ., Canberra); Robson, D. Phys. Lett., 25B: 504-6(Oct. 30, 1967).

It is shown that the Lippmann-Schwinger equation for potential scattering may be derived from the Bloch scattering theory by a suitable generalization of the Bloch L-operator to include the point at infinity. (auth)

5911 THEORY OF PROTON-PROTON BREMSSTRAHLUNG CONSISTENT WITH EXPERIMENT. Brown, V. R. (Univ. of California, Livermore). Phys. Lett., 25B: 506-9(Oct. 30, 1967).

Proton-proton bremsstrahlung is calculated with the Bryan-Scott and the Hamada-Johnston potentials. Quantitative agreement with existing experiments, including photon angular distributions, is obtained. The results disagree in part with those of previous calculations. (auth)

5912 COHERENT SCATTERING OF GAMMA-RAYS. Nath, Amalendu. (Bose Inst., Calcutta). Trans. Bose Res. Inst., 29: No. 2, 51-83(June 1966).

An attempt is made to present a comprehensive up-to-date account of knowledge on the phenomenon of coherent scattering of γ rays in the energy range usually covered by γ rays obtainable from radioactive sources, i.e., roughly in the range 0 to 2.80 MeV. The over-all interest in the report is to present general information which is experimentally useful for the estimation of the coherent scattering intensity in the general case. The greater part of the report is devoted to Rayleigh scattering, the most predominant coherent scattering process in this energy range. A general introduction to the different theories proposed to account for the process is given. Major emphasis is given to the experimental literature, which was compiled and critically surveyed to bring out the general features of the process at various γ-ray energies and for scatterers of different atomic numbers. Problems of experimental measurements of coherent scattering cross-sections are discussed in some detail and various important sources of error to be considered in this context are pointed out. At low momentum transfer experimental data are specifically compared with different form-factor calculations to establish their range of validity. Finally, Delbrück scattering is briefly described. Experimental data are examined in the context of experimental evidence of Delbrück scattering in the energy range considered. (auth)

5913 KINEMATICS OF NUCLEAR REACTIONS. Michalowicz, A. London, Iliffe Books Ltd., 1967. 140p. 18s.

Translation from French text Cinematique des Reactions Nucleaires.

The subject is discussed under the following main headings: fundamental relations and notation; kinematics of low-energy collisions; and relativistic kinematics. A collection of numerical tables which will be useful in kinematic calculations is included. (UK)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 4303, 4314, 4346–4348, 4408–4414, 4416, 4417, 4753, 4772, 4822, 4860, 4878, 4906, 4911, and 4912.

5914 (AECL-2944) PLUTONIUM PRODUCTION AND RECYCLE IN HEAVY WATER REACTORS. Duret, M. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Sept. 1967. 28p. (CONF-670917-7). Dep. CFSTI. CAN.

From Symposium on Heavy Water Power Reactors, Vienna, Austria.

It is important to be able to calculate accurately the Pu content and isotopic composition of fuel discharged from heavy water moderated reactors. Comparisons of fuel composition measurements with calculations have been reported in Vienna this spring for a fuel bundle with an irradiation of 5500 MWd/t. Similar results are described for a 19 element UO_2 bundle irradiated in the NPD reactor to about 9700 MWd/t. To assess the effect on both the capital cost and fuel cost of a 500 MW BLW moderated with heavy water and cooled with boiling light water, exploratory calculations are being made. The Pu fuel is assumed to be produced in a heavy water moderated reactor of the Pickering type with a fuel burnup of 9000 MWd/t. This corresponds to a Pu composition of ^{239}Pu: ^{240}Pu: ^{241}Pu: ^{242}Pu: 0.62: 0.295: 0.0625: 0.022. For these initial calculations, the Pu is uniformly mixed with U in the form of PuO_2 in UO_2. These survey calculations investigate changes in a variety of reactor and plant parameters such as lattice pitch, coolant pressure, etc. Large fuel channels containing large amounts of light water will tend to produce a large positive void coefficient. The value of the void coefficient is calculated. Variations in Pu concentration are considered since if the use of Pu is economically advantageous, it will affect the overall power system by indicating the best division of power generation between CANDU-PHW's and BLW's. The performance is compared with a natural U BLW. This procedure minimizes uncertainties in the estimates of capital costs for the two systems. (auth)

5915 (AEEW-R-538) THE PREPARATION OF INPUT DATA FOR WIMS. Roth, M. J.; Macdougall, J. D.; Kemshell, P. B. (Atomic Energy Establishment, Winfrith (England)). Aug. 1967. 38p. Dep. CFSTI. UK.

WIMS (Winfrith Improved Multigroup Scheme) is a general code for reactor lattice cell calculations on a wide range of reactor systems. This manual describes the preparation of input data and control instructions for the KDF 9 computer, together with the layout of the output edit information; versions for STRETCH and IBM 360 are expected to be available later. The basic library has been compiled with 14 fast groups, 13 resonance groups and 42 thermal groups, with the option of accurate solutions in many groups or rapid calculations in few groups. The code permits lattice calculations, including burnup, in a number of different geometric options, including annular, slab, r-s, and cluster geometries. Extensive editing options include the determination of spatial reaction rates of detector materials, including appropriate shielding of resonances for those which are constituents of the fuel. (auth)

5916 (AEEW-R-551) ON THE IMPORTANCE OF FAST SCATTERING DATA FOR ALUMINIUM IN THE INTERPRETATION OF RESULTS FROM H_2O-MODERATED LATTICE EXPERIMENTS. Fayers, F. J.; Terry, M. J. (Atomic Energy Establishment, Winfrith (England)). July 1967. 16p. Dep. CFSTI. UK 3s. 6d.

The importance of scattering data for Al in leakage calculations for light water systems is examined. It is shown that some discrepancy exists between calculated plane moments and experimentally measured moments, which may be corrected by an 'ad hoc' adjustment of inelastic scattering data for Al. WIMS results are presented for some Battelle Pu–Al fuelled rod lattices, and it is shown that this adjustment of inelastic data leads to a noticeable correction for the predicted reactivities of the experiments. The influence of scattering data for Al on results for some other lattices of interest is shown to be less important. (auth)

5917 (APIO-1038) PHYSICS FOR REACTOR OPERATORS. Masche, G. C. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 1966. 209p. Dep. CFSTI.

A set of reactor physics notes is presented to serve as the basis for a classroom training course. Physics points which should be of primary interest to the operator and enable him to meet any reasonable operator requirement are stressed. The basic scientific principles of reactor operations are discussed in sections containing background information on nuclear physics, neutron behavior, and criticality equations. Characteristics of the reactor operating at power and general hazards guidelines necessary for safe plant operation are presented. (H.D.R.)

5918 (CEA-Bib-78) LES BREVETS EN MATIERE DE DETECTION DE RUPTURES DE GAINES. (Patents in the Field of Can-Rupture Detection). (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1967. 141p. (In French). Dep.

The abstracts of patents issued in the principal industrial countries are listed according to several chapters pertaining to the general principles of leak detection, detection itself of fission products, apparatus used directly or in combination with and for the purpose of detection, the indication and treatment of the data given, the examination before and after use of cartridge jackets. A cumulation list is appended giving in progressive order of the patent numbers, for 18 countries, to facilitate the search of the abstract in the corresponding chapter. (auth)

5919 (CONF-671011-2) BENEFITS AND LIMITATIONS OF DESIGNING FOR NUCLEAR POWER PLANT SAFETY SYSTEM TESTABILITY. Sowards, N. K. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Nov. 1, 1967. 8p. Dep. CFSTI.

From Conference on Incipient Failure Diagnosis for Assuring Safety and Availability of Nuclear Power Plants, Gatlinburg, Tenn.

The situations and conditions unique to a real accident environment are kept uppermost in the design of a system and the provisions for testing it. A series of periodic operability tests does not necessarily achieve a high degree of assurance for safety function. A systems engineering approach is described for any unique system design analysis. (D.C.C.)

5920 (EUR-3633e) THE CODES COSTANZA FOR THE DYNAMICS OF LIQUID-COOLED NUCLEAR REACTORS. Forti, G.; Vincenti, E. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug. 7, 1967. 112p. Dep.

The two codes COSTANZA cylindrical and COSTANZA axial, written in FORTRAN-H for IBM 360/65, solve the kinetics diffusion equations in two groups and one dimension (plane geometry for COSTANZA axial, radial geometry for COSTANZA cylindrical). The neutronic calculation is coupled with the calculation of the heat transmission from the fuel to the cladding and to the coolant, and with the thermohydraulics of channels with forced circulation of liquid coolant. The geometry of fuel element and channel may be cylindrical or slab. Up to ten groups of delayed neutrons are allowed. Temperature feedback of fuel (Doppler) and coolant are considered independently and affect the nuclear constants. Control rod movement or diffused poison concentrations are simulated by externally imposed variations of the thermal absorption cross section in the different regions of the reactors. Inlet temperatures and mass flow in the coolant channels may be varied according to any externally given time table. (auth)

5921 (EURFNR-398) REACTIVITY COEFFICIENTS OF STEAM-COOLED FAST BREEDERS. Kiefhaber, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Oct. 1967. 20p. (EUR-3673e; KFK-629; CONF-671043-8). Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

From Symposium on Fast Reactor Physics and Related Safety Problems, Karlsruhe, Germany.

Design parameters which affect the stability-behavior of steam-cooled fast breeder reactors are presented. These parameters of influence are: isotopic composition variations during burnup for Pu; cladding materials; heavy water coolant; fuel nitrides; and geometric arrangement of the core. (D.C.C.)

5922 (EURFNR-399) THE LONG-TIME BEHAVIOUR OF FAST POWER REACTORS WITH Pu-RECYCLING. Jansen, A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Oct. 1967. 22p. (EUR-3674e; KFK-630; CONF-671043-7). Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

From Symposium on Fast Reactor Physics and Related Safety Problems, Karlsruhe, Germany.

The long-time behavior of the Pu composition in the fuel and the physical aspects of the fuel cycle economy under conditions of loading and unloading the core and blanket elements is described. The loading and the unloading of the core and blanket

elements are treated as discontinuous processes. The solution presented is applied to a Na-cooled 1000 MW(e) power reactor. (D.C.C.)

5923 (EURFNR-402) HETEROGENEITY CALCULATIONS INCLUDING SPACE DEPENDENT RESONANCE SELF SHIELDING. Wintzer, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Oct. 1967. 23p. (EUR-3677e; KFK-633; CONF-671043-11). Dep. CFSTI.

Work performed under United States-Euratom Fast Reactor Exchange Program.

From Symposium on Fast Reactor Physics and Related Safety Problems, Karlsruhe, Germany.

A method to determine heterogeneity effects on the reactivity is described for a lattice cell containing material of large resonance cross sections that takes into account space dependent self shielding in a multiregion lattice cell. The method is based on a multigroup collision probability formalism of reaction rates and neutron emission densities in the cell regions and is applied in a computer program called ZERA. This method can be applied to thermal reactor problems. Several results of ZERA calculations for rod lattices and for plane lattices are presented and compared with experimental results. (D.C.C.)

5924 (EURFNR-405) SYSTEMS ANALYSIS OF A FAST STEAM-COOLED REACTOR OF 1000 MW(e). Frisch, W.; Hofmann, F.; Kiefhaber, E.; Moers, H.; Schramm, K.; Smidt, D.; Spilker, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Oct. 1967. 24p. (EUR-3680e; KFK-636; CONF-671043-5). Dep. CFSTI.

Work performed under United States-Euratom Fast Reactor Exchange Program.

From Symposium on Fast Reactor Physics and Related Safety Problems, Karlsruhe, Germany.

The Karlsruhe design of a steam cooled fast reactor (D1) has been the subject of a systems analysis. The dependence of fuel inventory, breeding ratio, rating, core geometry and plant efficiency on coolant pressure, and coolant temperature has been studied for two different rod powers. The effect of artificial surface roughness has been investigated. For some configurations the resulting fuel cycle and capital costs have been determined and discussed. The main influence results from pressure. The lower pressure allows for higher breeding ratios, but lower efficiencies and vice versa. From this the fuel cycle costs show an optimum in the range of 150 ata. The capital costs on the other side decrease with pressure. The overall optimum of the power generating costs for the presently studied parameter range is at about 170 ata, a coolant outlet temperature of 540°C and a rod power of 420 W/cm. Artificial roughness (boundary layer type) leads for a required system pressure and outlet temperature to a larger coolant volume fraction, and, therefore, to reduced breeding ratios, but higher efficiencies. Some stability characteristics of the cores have been studied. The dependence of the core stability on the varied parameters is shown. (auth)

5925 (GEAP-5510) TERMINAL EXAMINATION AND EVALUATION OF EVESR MARK II ANNULAR SUPERHEAT FUEL. Rittenmyer, G. J. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Sept. 1967. Contract AT(04-3)-189. 96p. Dep. CFSTI.

The experimental fuel designated Mark II was irradiated as part of the EVESR Nuclear Superheat Fuel Development Program. The initial loading of this fuel in EVESR consisted of 32 bundles, each composed of nine fuel rods. The Mark II fuel tests were designed primarily as a cladding materials test. On the basis of previous out-of-pile work, five test cladding materials were selected: Incoloy-800, Inconel-600, Types-310 and -304 vacuum melted stainless steels, and Type-304 commercial grade stainless steel. Results of post-irradiation examinations of lead fuel rods clad with these five test materials following shutdown of the reactor are documented. (auth)

5926 (HPR-90) SUMMARY OF THE EXPERIENCE FROM THE 1964-66 EXPERIMENTAL OPERATION OF THE HBWR. A Compilation of HBWR Papers Presented at the Symposium on Heavy Water Power Reactors, Vienna, September 11-15, 1967. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). 83p. Dep. CFSTI.

Topics discussed include: reactor description; control rod assembly; fission gas collection system; material buckling; reactivity; thermal flux distribution; fuel element assembly; burnout detectors; and coolant flow. (D.C.C.)

5927 (IBK-466) NUMERICAL CALCULATION PROCEDURE FOR CRITICALITY PARAMETERS OF THE TWO-ZONE REFLECTED REACTOR WITH FLAT CENTRAL ZONE. Bosevski, T.; Strugar, P. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). Oct. 1966. 7p. Dep.

The Newton method for solving a system of two non-linear equations is presented. The non-linear equations are obtained in determining the criticality parameters for a two-zone reactor with flat central zone. (D.C.C.)

5928 (IBK-532) CONTINUAL EXCHANGE OF FUEL IN REACTOR WITH THE FLAT CENTRAL ZONE. Bosevski, T.; Strugar, P.; Pop-Jordanov, J. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). Mar. 1967. 23p. Dep.

An improved calculation procedure for continual fuel exchange in natural U fuel reactors is presented. The reactor configuration has two-zone with a flat central zone. By using continual fuel exchange the flattening of the thermal neutron flux in the central reactor zone can be achieved. (D.C.C.)

5929 (KAPL-P-3372) DATATRAN: THE INPUT LANGUAGE FOR THE NOVA MODULAR PROGRAM SYSTEM. BASIC PHILOSOPHY AND EXPERIENCE. Knolls Atomic Power Lab., Schenectady, N. Y.). [1967]. Contract W-31-109-eng-52. 7p. (CONF-670830-1). Dep. CFSTI.

From Applied Mathematics Division Colloquium, Argonne, Ill.

The description of the input language for the NOVA module system for reactor design is presented. The inter-module communication using DATATRAN allows programs to be written and tested rapidly. (D.C.C.)

5930 (NP-17085) PEACH BOTTOM ATOMIC POWER STATION. Monthly Operations Report No. 19, September 1967. (Philadelphia Electric Co., Pa.). 27p. Dep.

Topics discussed include: plant operations; testing; radioactive effluents analysis; radiation surveys and exposures; chemistry; and maintenance. (D.C.C.)

5931 (NP-17110) TENTH GENERAL REPORT ON THE ACTIVITIES OF THE COMMUNITY (MARCH 1966-FEBRUARY 1967). (European Atomic Energy Community). Apr. 1967. 415p. Dep.

Includes Documentation Attached to the Tenth General Report.

Topics discussed include: homogeneous reactors; heavy water and organic-liquid reactors; proven-type reactors; fog-cooled reactors; advanced gas reactors; fast neutron reactors; plasma physics and controlled fusion; irradiated fuel reprocessing; labelled molecules and radioisotopes; industrial applications of radioisotopes; nuclear marine propulsion; materials testing reactors; Pu and transplutonium elements; reactor and neutron physics; biology; nuclear risk insurance; safeguards and controls; and nuclear plant safety. (D.C.C.)

5932 (NP-17118) O.E.C.D. HIGH TEMPERATURE REACTOR PROJECT DRAGON EIGHTH ANNUAL REPORT, 1966-1967. (Organization for Economic Co-Operation and Development, Paris (France)). 174p. Dep.

Described is the progress of the Dragon Project for the period from April 1, 1966, to March 31, 1967. Separate sections cover research and development, operation of the reactor experiment, power reactor assessment studies and project administration. Research and development effort was concentrated on fuel element production, testing, and examination and the evaluation of reactor operating conditions. The year marked the first extended operation of the reactor at full power. First and second fuel charge irradiations were carried out, and extensive adjustments, examinations, and measurements were performed on plant components and systems. Assessment studies to establish the feasibility, safety, and costs of all the features essential to a practical high temperature gas-cooled nuclear power station were evaluated. A reference design was evolved for a 1,250 MW(t) (528 MW(e)) single reactor station using a highly enriched uranium/thorium fuel cycle, and a variant design using slightly enriched uranium fuel only is discussed. (H.D.R.)

5933 (NP-17145) PEACH BOTTOM ATOMIC POWER STATION. Monthly Operations Report No. 20, October 1967. (Philadelphia Electric Co., Pa.). 15p. Dep.

Topics discussed include: plant operations; testing; radioactive effluents analysis; radiation surveys and exposures; chemistry; maintenance; and facility alterations. (D.C.C.)

5934 (RT/EC-(67)1) DISPONIBILITA DI PLUTONIO E PROGRAMMA REATTORI VELOCI. Studio Analitico. (Availability of Plutonium for the Fast Reactor Program. Analytical Study). Scuricini, G. B.; Lavrencic, D.; Valant, P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). June 6, 1967. 22p. (In Italian). Dep.

In any nuclear power program for the installation of Pu-fueled fast reactors, the determination of the installable fast reactor power from one year to the next in the light of available Pu is of fundamental importance. A sufficiently rigorous mathematical solution of this problem is proposed. (auth)

5935 (JPRS-42542) THREE-DIMENSIONAL CALCULATION OF FUEL BURN-UP IN WATER-COOLED, WATER-MODERATED POWER REACTORS. Novikov, A. N.; Petrunin, D. M.; (and others). Translated from the Panel Burn-up Predictions in Thermal Reactors, Vienna, April 10–14, 1967, Moscow. 19p. (TT-67-33170). CFSTI.

Two- and three-dimensional programs for analyzing the physical and thermal characteristics of water-cooled, water-moderated reactors are described. The programs were used to calculate the effectiveness and the critical locations of control rods, determine the thermal and temperature capacities, and calculate the burnup of fuel. (D.C.C.)

5936 (JPRS-43265) NUCLEAR ENERGY INSTALLATIONS AND THEIR TECHNICAL POSSIBILITIES. Summary Report. Leipunskii, A. I. Translated from Kernenergie, 10: 177-81 (1967). 10p. (TT-67-33889). CFSTI.

The importance of nuclear reactors in the field of power production is discussed. Various reactor types are presented with information on the countries which use them. The fuel economics in reactor development are discussed, and the importance of the fast reactors in Pu production is emphasized. Projection for the construction of commercial, fast breeder reactors with high efficiency is presented for the 1970's. (D.C.C.)

5937 EFFECT OF THE STAINLESS-STEEL REFLECTOR ON THE POWER COEFFICIENT OF EBR-II. Kirn, F. S.; Long, J. K.; Smith, R. R. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 10: 648 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5938 GAS COOLING FOR FAST BREEDERS. Donne, M. Dalle; Wirtz, K. (Gesellschft fuer Kernforschung mbH, Karlsruhe, Ger.). Trans. Amer. Nucl. Soc., 10: 649 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5939 GAS-COOLED FAST-REACTOR PERFORMANCE WITH VARIOUS DEGREES OF SURFACE ROUGHENING. Melese-d'Hospital, G. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 649-50 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5940 SOLUTION FOR FLUID CONDITIONS IN HIGH-VELOCITY FLOW. Hansen, Kent F.; Mason, Edward A.; Robba, Arnold A. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 10: 650-1 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5941 IN-PILE HEAT-TRANSFER STUDIES OF ROUGHENED HELIUM-COOLED REACTOR FUEL ELEMENTS. Brandon, C. A.; Kidd, G. J. Jr. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 651-2 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5942 TURBULENT THERMAL ENTRY WITH GAS-TRANSPORT PROPERTY VARIATION. Magee, P. M. (Atomics International, Canoga Park, Calif.); McEligot, D. M. Trans. Amer. Nucl. Soc., 10: 652-3 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5943 GENERAL DESCRIPTION OF A 1000-MW(e) LOW-PRESSURE STEAM-COOLED BREEDER REACTOR. Schluderberg, Donald C. (Babcock and Wilcox Co., Lynchburg, Va.); White, Donald P. Trans. Amer. Nucl. Soc., 10: 643 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5944 NUCLEAR, THERMAL, AND HYDRAULIC CHARACTERISTICS OF THE BABCOCK AND WILCOX LOW-PRESSURE STEAM-COOLED BREEDER REACTOR (SCBR). Wolfe, G. E.; Straub, R. V. (Babcock and Wilcox Co., Lynchburg, Va.). Trans. Amer. Nucl. Soc., 10: 643-4 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5945 USE OF UNCLAD-METAL FUEL IN HIGH GAIN BREEDERS FOR DESALTING OR POWER. Hammond, R. P.; Anderson, T. D.; Burwell, C. C.; Wichner, R. P.; Lloyd, D. B.; Savolainen, J. E.; Delene, J. G.; Carlsmith, R. S. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 644-5 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5946 SEFOR REFUELING CELL DESIGN CONCEPT. Franckx, L. C.; Silvester, A. G. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 10: 645 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5947 REACTOR-SERVICING AND FUEL-HANDLING OPERATIONS IN THE SEFOR REFUELING CELL. Brynsvold, G. V.; Collins, G. D.; Franckx, L. C.; Pohl, L. E.; Silvester, A. G.; Steamer, A. G. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 10: 645-6 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5948 ANALYSES AND SIGNIFICANCE OF INITIAL EBR-II MARK I CLUSTER FAST-REACTOR SAFETY INTEGRAL LOOP EXPERIMENTS IN TREAT. Dickerman, C. E.; Purviance, R.; Cohen, A. B. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 698 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

5949 CHARACTERISTICS OF VAPORIZED UO_2 AEROSOLS IN AIR. Nelson, C. T.; Koontz, R. L.; Baurmash, L. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 698-9 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

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6024 ECONOMIC CONSIDERATIONS OF PLUTONIUM UTILIZATION IN BOILING-WATER REACTORS. Macnabb, W. V. (General Electric, San Jose, Calif.). Trans. Amer. Nucl. Soc., 10: 499(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6025 THE EBWR PLUTONIUM DEMONSTRATION EXPERIMENT. Dawson, F. G. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 500(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6026 POSTOPERATION EVALUATION OF THE PIQUA CORE-I FUEL ASSEMBLIES. Miller, K. J.; McCurnin, W. R. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 479-80(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6027 DYNAMIC ANALYSIS OF LARGE FAST REACTOR. Oyama, Akira (Tokyo Univ.); An, Shigehiro; Saito, Shinzo. J. Nucl. Sci. Technol. (Tokyo), 4: 545-54(Nov. 1967).

The dynamic behavior of a 1,000 MW(+) Na-cooled oxide-fuel fast breeder reactor was analyzed. To determine the stability of fast reactors, a new analytical model was introduced. The transfer function of EBR-1 Mark IV calculated therewith agreed closely with experimental data, and the stability study on the model case was carried out with this model. The present analysis was extended to cover such accidents as reactivity insertion, coolant flow coast down, and loss of coolant flow, which are commonly considered in fast reactor safety analysis, and further, the influence of changes in reactivity coefficients upon the consequences of such accidents was also surveyed. The results indicated no appearance of instability in large fast reactors under credible conditions, and that fuel center melting should occur prior to Na boiling in the case of a reactivity insertion accident, when the Doppler coefficient should have great influence, in contrast to the Na coefficient, whose effect should be small. It was also ascertained that there should be no fear of coolant flow coast down from pumping power failure if the scram system operates normally, and that in the event of channel blockage Na should begin to boil within a few seconds at about two thirds of core height. Compared to the case of reactivity insertion, the effects of the individual coefficients were found to act in the inverse direction in these latter cases. (auth)

6028 DIGITAL REACTOR PHYSICS CALCULATIONS. II. Bustraan, M. Atoomenergie Haar Toepass., 9: 192-202(Sept. 1967). (In Dutch).

The reactor physics calculations were sketched on the basis of the program aims of the RCN. In particular calculations of microscopic MA spatial distributions, fission calculations, time dependent calculations, and related problems were considered in particular. (tr-auth)

6029 THE PLACE OF NUCLEAR ENERGY IN THE NETHERLANDS' ENERGY SUPPLY. Muysken, M. Atoomenergie Haar Toepass., 9: 187-91(Sept. 1967). (In Dutch).

The total energy consumption in the Netherlands up to the year 2000 was estimated. The possible contribution of nuclear energy to the total electrical output was evaluated. (tr-auth)

6030 EVOLUTION OF NUCLEAR POWER IN CANADA. Haywood, L. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Eng. J. (Montreal), 9: 49-53(Oct. 1967).

The history and projection of future development of nuclear power in Canada, urging the minimizing of capital costs and the introduction of automation for operating routines, and vigorous research and development, especially on materials are included in this survey. (auth)

6031 APPLICATION OF THE MAXIMUM PRINCIPLE TO REACTOR CONTROL. Hano, Ichiro; Tamura, Yasuo (Waseda Univ., Japan). Waseda Daigaku Rikogaku Kenkyusho Hokoku, No. 36, 154-7(Sept. 1966). (In Japanese).

When a large capacity of nuclear power stations is connected to a power system, the problem will inherently occur to control the start-up and shut-down scheme of the stations so as to meet the load fluctuations which are currently absorbed by the regulating capacity of hydrostations. A new computational approach to the minimization of xe poisoning which usually attains its peak value some ten hours after a reactor is shut down, thus delaying the restart time of the reactor, is presented. Xe poisoning can be re-

duced by carefully controlling the neutron flux in its shut-down stage. Since this optimizing problem constitutes a variational problem with a number of complex restrictions imposed on the system variables, conventional variational technique turns to be uneffective. The formulation of the problem is made based on the maximum principle and a few comments are given to its computational aspects. (auth) (NSA of Japan)

6032 FUNDAMENTAL THEORY OF THE GAS NUCLEAR REACTOR. Fujimoto, Yoichi; Namiki, Mikio (Waseda Univ., Japan). Waseda Daigaku Rikogaku Kenkyusho Hokoku, No. 36, 115-18(Sept. 1966). (In Japanese).

The fundamental theory of the gas nuclear reactor is developed for a preliminary attempt to find a possible new type of nuclear reactor apart from existing ones. The basic set of equations is formulated, from which it is shown that the gas nuclear reactor has a large negative value of the temperature coefficient. The dynamical behavior of the gas nuclear reactor is discussed in some detail in two characteristic cases of the oscillating operation around the equilibrium state and of the pulse operation with a large output power. (auth) (NSA of Japan)

6033 MONITORING OF AIR CONTAMINATION AT JPDR (JAPAN POWER DEMONSTRATION REACTOR). Yoshida, Yoshikazu (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 12: No. 10, 49-53(Oct. 1966). (In Japanese).

Traces of rare gases as fission products and ^{131}I have been detected in the off-gas and reactor water, respectively, since direct-cycle, boiling-water reactor JPDR (Thermal output 45 MW and electrical output 12 MW) operated in Dec. 1964. The monitoring system at JPDR consists of NaI counters for gases, GM counters for dust, and five sampling pipings (one for off-gas ducts, two for turbine rooms, and two with emergency out-off devices for reactor vessel). Air contaminations which occurred from January to March 1965 are given. A description is also made of the leakage of fission product gases from a connector in the off-gas panel, and air contaminations during the breakage of reactor instruments. (NSA of Japan)

6034 JPDR OPERATION RECORD AND EXPERIENCES. Suguri, Susumu (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 13: No. 1, 33-41(Dec. 1966). (In Japanese).

The JPDR has three main purposes: actual experiences on the construction, operation and maintenance of a nuclear power plant, experiments and tests to know the characteristics of a power reactor system; and various studies and developments, contributing to the domestic production of power reactors, by fuel-element performance tests, domestic-component characteristic tests, etc. The operation record and experiences of JPDR from the completion inspection until the present are described in the following sections; completion inspection; operation record (an outline of the JPDR operation, and a 1000-hr continuous operation); radiation control; tests and experiments with JPDR (reactor-physical, thermo-hydrodynamic and kinetic characteristic tests, plant characteristic tests, and domestic-fuel irradiations); and co-ordination with power companies. (NSA of Japan)

6035 TRANSPORT OF USED NUCLEAR FUEL. Takayanagi, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 13: No. 4, 23-9(Apr. 1967). (In Japanese).

JRR-2 of Japan Atomic Energy Research Institute operates at 10 MW in 17 cycles per year. Some 40 spent fuel rods are discharged in a year, with average burn-up 20%. Since these fuel rods are rented from the United States they must be returned immediately after the consumption. The overseas transport of spent fuel is described in the following sections: reprocessing agreement; transport container and the used nuclear fuel; removal of the "useless" part of used fuel-rods; containment of used nuclear fuel; transport in Japan; transport in the Pacific Ocean; transport in the United States; and turnover of the used fuel. (NSA of Japan)

6036 LIQUID METAL FAST BREEDER REACTOR PLANNED BY ESADA. EEI (Edison Elec. Inst.) Bull., 35: 293(Sept. 1967).

The Empire State Atomic Development Associates, Inc. (ESADA) has committed $5 million for the development of key components for a breeder reactor concept. The work will be carried out by General Electric Co., and require 3 yr to complete. Construction of a 300,000-kW demonstration plant somewhere in New York State is planned on a 1975 completion schedule. The over-all program, including plant construction, will cost ~$100 million. The reactor being developed is a liquid metal fast breeder (LMFBR), i.e., using a liquid metal coolant (specifically Na) and operating with fast neutrons. The fuel is a mixture of Pu and U oxides. Through extremely efficient neutron utilization, such a reactor system can accomplish a sufficiently high rate of conversion of fertile to fissionable fuel to achieve a net gain of fissionable material. Thus the LMFBR should achieve lower fuel costs than conventional nuclear power plants. Another advantage of the LMFBR is that the use of liquid Na as the reactor coolant permits achieving high temperatures, and hence high efficiency in the conversion of heat to electricity in an essentially unpressurized system. (BBB)

6037 RESEARCH PROJECT ON THE USE OF PLUTONIUM IN WATER REACTORS. EEI (Edison Elec. Inst.) Bull., 35: 290-1(Sept. 1967).

The use of Pu as a replacement fuel for ^{235}U in boiling-water power reactors is discussed. Based on an ore cost of $5.75/lb of U_3O_8, calculations showed that Pu is worth about $7500/kG as a thermal reactor fuel if the cost of fabrication equals that for U fuel. It costs more to fabricate Pu fuel than U fuel because its toxicity requires special handling in enclosed spaces. Pellet fuel is the preferred design concept for Pu at this time, but mechanically packed physical mixtures of Pu and U oxide powders may lower fabrication costs. The large industrial acceptance of pelletized fuel has led to the choice of hot pressed pellets of Pu for additional testing. Hot pressed fuel has been extensively studied out-of-reactor and has undergone successful irradiation testing in a test reactor. Seventy-seven fuel rods have been fabricated and 19 of these are now being irradiated under high performance power-reactor conditions. Other studies in progress involve pressing and sintering of pellets. Design studies have concentrated on focusing the vast amount of available Pu utilization data to achieve a workable economic Pu fuel design. The chosen design closely resembles a standard U bundle in that the fuel enrichments vary across the bundle to flatten the power distribution with Pu contents varying from about 1 to 5%. Studies were also conducted on potential problems of Pu segregation as it might affect thermal and nuclear performance. (BBB)

6038 NUCLEAR ENERGY FOR DESALINATION. Brice, D. B.; Briggs, D. S. (IAEA, Vienna). Desalination, 2: 89-98(1967).

The economic advantages in combining desalination with electrical power production in a dual-purpose water and power plant are pointed out. The ratio of water-to-power output for a dual-purpose nuclear desalination plant is limited at present by technical considerations to about 45 to 125 l/Kw-hr. Some actual ratios of water-to-power use per capita are considered. Developments in nuclear reactors are expected to reduce steam costs to 8 to 12 cents per million Kcal. The corresponding cost of desalted water, allowing for reoptimization of the desalination plant, would be about 3 cents per m^3. Except in specific cases, the economic use of desalted water for irrigation will not be possible as long as its production cost without subsidy is more than about 1.5 cents per m^3. As the application of water for irrigation is presently practiced, only when this cost can be reduced to the order of 0.5 cents per m^3 will the use of desalted water for irrigation be developed on a very large scale. (BBB)

6039 DESIGN METHODS FOR NUCLEAR POWER PLANT SYSTEM DESIGN. Craft, P. C. R. (Coll. of Aeronautics, Cranfield, Eng.). Ergonomics, 10: 221-4(Mar. 1967).

Innovations in nuclear power plant design, introduced in the Wylfa Nuclear Power Station (England), are described. The innovations include: the change from steel to concrete for the reactor pressure vessels; from a pond to a dry store for the spent irradiated fuel; and from a crane to remotely controlled vehicles for transporting the reactor fueling and servicing machines. The control of the station is almost entirely centralized within a single central control room, and a computer system is used for data processing and control. The twin-reactor data processing system deals with some 4500 analogue and 3000 contact signals, carries out 3300 alarm level checks every 30 sec, and analyzes about 6000 possible alarms. The pattern of the technology applied in the Wylfa design consisted in a large set of sub-system technical design organizations co-ordinated by an essentially different management organization. Some general lessons that emerge from this design work are outlined. (BBB)

6040 FUEL ELEMENTS FOR THE AVR AND THTR HIGH TEMPERATURE REACTORS. Hrovat, M. (Nuclear-Chemie und- Metallurgie GmbH., Wolfgang, Ger.); Huschka, H.; Spener, G.; Venet, P. Energ. Nucl. (Paris), 9: 373-85(Oct. 1967). (In French).

A process for the manufacture of fuel elements in pellet form was developed for the AVR gas cooled, high temperature reactor. The fuel element is made up of spherical particles of $(U,Th)C_2$, coated with a layer of pyrolytic carbon and placed in a hollow pellet of graphite. Radiations, done as much on the particles as on the fuel elements themselves, showed that a high combustion rate can be attained. In order to improve the elements and decrease their manufacturing cost, with special reference to the THTR prototype reactor, parallel development research is being

done on fuel particles with different compositions and coating structures; on fuel elements of graphite with free particle filling; and on molded spherical elements. (auth)

6041 HIGH-TEMPERATURE REACTORS IN EUROPE. Valette, L.; Tytgat, D. Energ. Nucl. (Paris), 9: 358-72(Oct. 1967). (In French).

High-temperature gas-cooled reactors are being developed under three projects, two European and one American. Although the core geometries are not identical, some basic technological principles common to all were developed under a research programme serving to back up the construction of test reactors. The experience acquired in the construction and operation of the European reactors is briefly reviewed. Some technical and economic evaluation studies were recently published in connection with the Dragon-THTR Symposium held in Brussels in May 1967. The economic prospects seem promising both for countries with a long experience of gas-cooling and for those where this technique is a new departure. (auth)

6042 THE NATIONAL NUCLEAR POWER PROGRAMME OF THE UNITED KINGDOM. Kronberger, H. (United Kingdom Atomic Energy Authority, Risley, Eng.). Reactor, 6: 2-7(Sept. 1967).

In the almost completed phase I of the UK nuclear power programme, Magnox reactors with a total capacity of 4,750 MW(e) are being installed. Phase II reactors (AGR's) are planned giving an aggregate capacity of 6,350 MW(e). This total will be increased to 8,000 to 10,000 MW(e) in the period 1970–1975. For phase III, generation by the first commercial fast reactor is expected some time after 1975, and further advanced reactors designs are being studied. (UK)

6043 UK NUCLEAR POWER STATIONS. J. Brit. Nucl. Energy Soc., 6: 279-83(Oct. 1967).

The current status of the Electricity Boards' programmes is presented. Data are given on performance and construction progress of the Magnox and AGR stations. (UK)

6044 DESIGN OF FUEL ELEMENTS FOR GAS-COOLED NUCLEAR REACTORS. Brown, G. (Atomic Power Constructions Ltd., London); Packman, G.; Waters, J. D. Proc. Inst. Mech. Eng. (London), 180: 727-55(1965-6).

The fuel element is considered as an integral part of the reactor and design factors are discussed. The development of fuel element design is traced historically, and the effects on can temperature of variations in axial and radial heat production and in heat removal are considered. Development work to establish the feasibility of a new fuel element is necessary before, during, and after irradiation. Tests on material properties, corrosion behaviour, and heat transfer are discussed. Future developments are considered, with particular reference to unit generation cost. Higher rating, increase in thermal efficiency through higher temperature, and longer fuel life are the aims. (auth) (UK)

6045 MECHANICAL ENGINEERING ASPECTS OF CONCRETE REACTOR PRESSURE VESSELS FOR OLDBURY NUCLEAR POWER STATION. Lakin, R. W. (Nuclear Power Group, Knutsford, Eng.). Proc. Inst. Mech. Eng. (London), 180: 927-48(1965-6).

In the Oldbury reactors the core, boilers, and gas circuits are contained within the same vessel. The design and construction problems and their solution are described in relation to the vessel liner, boiler shield wall, circulation outlet duct, insulation, and boilers. Tests on plate buckling, coolant flow, and insulation are outlined. The importance of the effects of the construction programme on the design is stressed, and improvements possible in future designs are discussed. (UK)

6046 STRESS SIMULATION ON CANNING MATERIALS FOR TUBULAR FUEL ELEMENTS. Francke, K. P.; Garzarolli, F.; Weidinger, H. G. (Allgemeine Elektricitaets-Gesellschaft AEG-Telefunken, Berlin). J. Nucl. Mater., 24: 215-22(1967). (In German).

The development of an integrated superheat boiling reactor led to the concept of a tubular fuel element with axial mechanical stresses of the canning tubes, variable with the reactor power. To test experimentally the theoretical stress model for this fuel element, a stress simulator was designed; this allowed stresses and plastic strains to be determined, for sections of canning tubes with realistic diameters and wall thickness, as a function of temperature. (auth)

6047 INDIRECT MEASUREMENT METHODS FOR INVESTIGATION OF FLOW PROCESSES IN PEBBLE BEDS. Bedenig, D.; von der Decken, C. B.; Rausch, W.; Schmidt, G. (Brown Boveri/Krupp, Juelich, Ger.). Tech. Mitt. Krupp. Forschungsber., 25: 37-45(July 1967). (In German).

With reference to the pebble bed high temperature reactors being developed in Germany, the knowledge of the flow behavior of a pebble bed is of importance. Indirect measuring methods are reported. The most important one is the method of residence spectra. To describe the flow behavior so-called characteristic functions are introduced. Experimental equipment is described and typical results are reported. (auth)

6048 DYNAMICS ANALYSIS OF A NUCLEAR BOILER. M'Pherson, P. K.; Collins, G. B.; Guppy, C. B.; Sumner, A. (Atomic Energy Research Establishment, Winfrith, Eng.). Proc. Inst. Mech. Eng. (London), 180: 417-50(1965-66).

A dynamics analysis of a nuclear boiler based on a steam-generating, pressure-tube, heavy-water-moderated design is presented. In effect the plant is very similar to a La Mont recirculating cycle. A detailed mathematical model to represent plant dynamics (linearized, full power) is discussed with special reference to the boiling channel, steam drum, and recirculating loop. A simplified model is derived for analogue computer studies. Dynamic performance is discussed in terms of: (1) boiler only (no reactivity feedbacks): influence of pressure feedbacks, steam drum design, subcooling, recirculating delay; (2) complete plant (including reactor): as above but including influence of void coefficient. The two most important results are: (1) the strong dependence of plant behavior/stability on the degree of float allowed to pressure; (2) the possibility of designing an inherently stable and self-regulating plant with a small positive void coefficient. Conclusions are drawn on the complete dynamic analysis under the heads: (1) optimal plant design; (2) control system design; (3) development of analytical/computing methods; (4) research into two-phase physics. (auth)

6049 NUCLEAR REACTOR. Arthur, Ian P.; Bell, Francis R. (to U. S. Atomic Energy Commission). U. S. Patent 3,359,175. Dec. 19, 1967.

Described is a gas-cooled nuclear reactor having a prestressed concrete reactor vessel in the upper portion of which the reactive core is supported by means comprising a plurality of columns extending between a core supporting floor and the lower floor of the reactor. (AEC)

6050 BURST-CARTRIDGE DETECTION UNITS. Boothroyd, Alan Denham; Cundill, Brian Randall (to English Electric Co., Ltd.) British Patent 1,093,142. Nov. 29, 1967. Filed Oct. 4, 1963.

The description of a burst-cartridge detection unit for detecting fission products released from burst or damaged fuel element cartridges in gas-cooled reactors is presented. The detection unit comprises a sampling pipe from each fuel element leading to an electrostatic precipitator chamber. After the sampled gas reaches the precipitator chamber, a flexible electrode collects the fission products and passes them to a radiation detector. (D.C.C.)

6051 NUCLEAR REACTOR OF THE PRESSURIZED WATER TYPE. McHugh, Bryan (to Aktiebolaget Atomenergi). British Patent 1,093,078. Nov. 29, 1967. Filed Dec. 15, 1964.

The description of a pressurized-water reactor is presented. The reactor system has a means for maintaining an overpressure in the reactor. The reactor system is comprised of a tank with a lower space for water and the fuel assembly, an upper space for steam, and a thermal barrier between the two spaces to reduce heat transfer from the steam space to the water space. (D.C.C.)

6052 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Hibbert, John (to United Kingdom Atomic Energy Authority). British Patent 1,092,536. Nov. 29, 1967. Filed May 25, 1964.

The description of a reactor with a non-oxidizing pressurized gas coolant and a pressure vessel with a fuel-containing moderator structure of combustible material is presented. The reactor environment is filled with a gas that does not support combustion. The reactor contains vertical fuel channels that are loaded both from the top and the bottom. (D.C.C.)

6053 POWER REACTOR PROGRESS IN THE UNITED KINGDOM. Bainbridge, G. R. (United Kingdom Atomic Energy Authority, London). 17p. (CONF-660450-1). DTIE.

From Advanced Gas-Cooled Reactor Symposium, Frankfurt am Main.

Development of nuclear power reactors in the United Kingdom is reviewed and the construction program is projected to the year 2000. The reactor types discussed include gas-cooled reactors with natural uranium metal fuel or slightly enriched uranium oxide fuel, steam generating heavy water moderated reactors, and fast breeder reactors. (H.D.R.)

6054 THE PERFORMANCE OF COMMERCIAL NUCLEAR POWER STATIONS IN THE U. K. Silverleaf, D. J. (Central

Electricity Generating Board, Berkeley, Eng.). 19p. (CONF-660450-9). DTIE.

From Advanced Gas-Cooled Reactor Symposium, Frankfurt am Main.

The power costs of magnox stations operating or under construction in the United Kingdom and the significant commissioning statistics are summarized. Performance statistics of the currently operating stations are presented and the maintenance and special problems encountered are discussed. (H.D.R.)

6055 WINDSCALE A.G.R. EXPERIENCE. Moore, J. (United Kingdom Atomic Energy Authority, London). 26p. (CONF-660450-8). DTIE.

From Advanced Gas-Cooled Reactor Symposium, Frankfurt am Main.

The information obtained from the Windscale AGR and from associated large scale experimental facilities is reviewed to present an outline of technical progress in the fields of engineering, fuel, materials, and physics. General plant and component performance since initial full power operation is summarized. (H.D.R.)

6056 SAFETY FEATURES AND SITING OF NUCLEAR POWER STATIONS. Farmer, F. R. (United Kingdom Atomic Energy Authority, London). 3p. (CONF-660450-5). DTIE.

From Advanced Gas-Cooled Reactor Symposium, Frankfurt am Main.

The various factors involved in the selection of sites for nuclear power reactors in the United Kingdom are examined. Siting criteria limitations based on population density, topography, and reactor reliability are discussed. (H.D.R.)

6057 ECONOMIC ASPECTS OF THE A.G.R. Franklin, N. L. (United Kingdom Atomic Energy Authority, London). 10p. (CONF-660450-6). DTIE.

From Advanced Gas-Cooled Reactor Symposium, Frankfurt am Main.

Items which make up the fuel cycle cost of an AGR reactor based on a 600 MW(e) design are discussed. The principal component costs examined are the cost of enriched uranium, the cost of fuel fabrication, the cost of transporting and reprocessing irradiated fuel, and the credit received for fissile material recovered from the spent fuel. The consequences of variations in typical fuel cycle cost assumptions are indicated. Total generating costs are estimated for a 600 MW(e) AGR reactor if constructed in Germany. (H.D.R.)

6058 GRAPHITE FOR A.G.R. POWER STATIONS. Hutcheon, J. M. (United Kingdom Atomic Energy Authority, London). 22p. (CONF-660450-7). DTIE.

From Advanced Gas-Cooled Reactor Symposium, Frankfurt am Main.

The effort devoted to the solution of problems associated with the use of graphite moderators in AGR power reactors is reviewed. Basic properties of graphite such as dimensional stability, creep, and thermal conductivity are discussed for conditions existing in an operating reactor. AGR specifications for graphite and methods used to prevent graphite losses or damage over the reactor operating life are examined. (H.D.R.)

6059 ECONOMIC ASPECTS OF THE A.G.R. Brown, G. (Atomic Power Constructions Ltd., Sutton, Eng.). 5p. (CONF-660450-3). DTIE.

From Advanced Gas-Cooled Reactor Symposium, Frankfurt am Main.

The capital and generation costs for the AGR and light water reactors are discussed from the standpoint of the alternative tenders received from industrial concerns for the Dungeness B Nuclear Power Station. (H.D.R.)

6060 THE DEVELOPMENT OF GAS-COOLED NUCLEAR REACTORS IN THE UNITED KINGDOM. Brown, G. (Atomic Power Constructions Ltd., Sutton, Eng.); Thorn, J. D. 22p. (CONF-660450-2). DTIE.

From Advanced Gas-Cooled Reactor Symposium, Frankfurt am Main.

The history and projected program for gas-cooled power reactor development in the United Kingdom are reviewed. Improvements in design and operating parameters and economic trends are discussed as the development program has progressed from magnox-clad natural uranium metal fueled reactors to high temperature stainless steel-clad ceramic uranium dioxide fueled reactors. (H.D.R.)

6061 THE DESIGN, DEVELOPMENT, AND SUPPLY OF FUEL FOR AN A. G. R. Thorn, J. D. (United Kingdom Atomic Energy Authority, London); Waddams, J. A. 18p. (CONF-660450-10). DTIE.

From Advanced Gas-Cooled Reactor Symposium, Frankfurt am Main.

The fuel used in advanced gas-cooled reactors is based on slightly enriched sintered UO_2 pellets encased in a stainless steel can. Some of the basic design and fabrication criteria and performance characteristics are reviewed for AGR fuel. The services introduced for the manufacture and supply of this fuel in Germany are outlined. (H.D.R.)

6062 DEVELOPMENT TRENDS IN CO_2-COOLED NUCLEAR POWER STATIONS. Thorn, J. D. (United Kingdom Atomic Energy Authority, London). 15p. (CONF-660450-11). DTIE.

From Advanced Gas-Cooled Reactor Symposium, Frankfurt am Main.

Current technical developments in CO_2-cooled reactors leading to lower costs are discussed. Advances in design and performance inprovements affecting the fuel and moderator, reactor and conventional plant components, and the way the reactor is used in a power generation system (siting, unit size, load factor) are summarized. The possibility of plutonium utilization and other long term developments in AGR systems are examined. (H.D.R.)

6063 THE DUNGENESS B NUCLEAR POWER STATION. Warner, P. C. (Atomic Power Constructions Ltd., Sutton, Eng.). 17p. (CONF-660450-12). DTIE.

From Advanced Gas-Cooled Reactor Symposium, Frankfurt am Main.

The main features of the AGR system design accepted for the Dungeness B station are described. The broad outline of the construction program is given and the basis of future development is indicated. (H.D.R.)

6064 DEVICE FOR CONTROLLING THE REACTIVITY OF A NUCLEAR REACTOR HAVING A FORCED COOLANT CIRCULATION SYSTEM. Margen, Peter Heinrich Erwin (to Aktiebolaget Atomenergi). British Patent 1,090,824. Nov. 15, 1967. Priority date Dec. 20, 1963, Sweden.

The description of a reactor with upward coolant flow is presented. A neutron absorbing body consisting of a plurality of balls of neutron absorbing material placed on top of each other in a tube has an open end in the coolant flow of the core and a closed end above the core. The control balls move vertically in the tube depending on the coolant flow rate through the core. (D.C.C.)

6065 DEVELOPMENT AND APPLICATION OF A SEMI-ANALYTIC APPROACH TO PHYSICS CALCULATIONS FOR FINITE, CYLINDRICAL GASEOUS-CORE CAVITY REACTORS. Wattelet, Paul Louis. Lafayette, Ind., Purdue Univ., 1967. 206p.

Thesis.

A method of finding critical masses and detailed two-dimensional flux distributions for completely reflected, finite, cylindrical gaseous-core cavity reactors is developed by the application of two-group diffusion theory in the reflector-moderator and integral probability theory in the cavity. The intervening region between the radial reflector and core is treated as a void, and all scattering in the core is neglected. The method is extended to include cores with nonuniformly disturbed fuel densities and limited amounts of structural materials. A computer program to evaluate the final criticality and flux solutions is presented along with results of a brief parametric study of uniform and nonuniform systems. Comparisons with results of previous diffusion studies are made. (Disser. Abstr.)

6066 DIRECT DIGITAL CONTROL STUDY FOR NUCLEAR REACTOR SYSTEMS. Partain, Clarence Leon. Lafayette, Ind., Purdue Univ., 1967. 193p.

Thesis.

By the use of digital simulation, the direct digital control of nuclear reactor systems can be studied. Direct digital control offers advantages over conventional analog control in that it can provide more flexible, efficient, and economic control. The development and optimization of an appropriate automatic control algorithm is described. This algorithm has been demonstrated to be valid under conditions of increasing reactor power, decreasing power, startup without neutron noise, startup in the presence of a Gaussian distribution of random noise, and orderly shutdown. The space-independent, six-delayed neutron groups, reactor model as well as the digital controller were simulated on the IBM 7094 digital computer. A detailed discussion and analysis of the development of the automatic digital control algorithm is presented. Z-transformation techniques were used to analyze the sampled-data control system. The use of an integrating sampler in the controller led to the definition of a new I-transformation. The validity, flexibility, and accuracy of the digital controller under various reactor conditions was demonstrated by sample case calculations. Time optimal control with magnitude constraints on the position and velocity of the manipulated variable was applied to the nuclear system. The control algorithm has also been optimized with respect to minimum time response within a predetermined maximum

allowable overshoot using a trial and error approach. A key result of the optimization study is the ability to determine appropriate switching points during an increase in reactor power as a function of initial power error. Favorable comparisons were made to previous work in nuclear reactor control. The application of the digital controller to the Dresden I Nuclear Power Plant is discussed. Long term effects of this approach to reactor control are evaluated. (Disser. Abstr.)

Marine and Portable Power Reactors

Refer also to abstracts 4303 and 4508.

6067 (EUR–3647e) NERO DEVELOPMENT PROGRAMME. Annual Report, 1966. Muysken, M. (comp.) (Reactor Centrum Nederland, [The Hague]). 1967. 17p. Dep.

The NERO Development Programme was drawn up to RCN and Euratom in order to prepare a design with specifications for an advanced pressurized water reactor for marine propulsion. During 1966 it became clear that the design of the core would have to be revised owing to insufficient reactivity control by the Y-shaped control rods. Satisfactory results were obtained with the preparation of UO_2 pellets with lumped burnable poison in UB_4 form. However, the irradiation experiments with these pellets had to be stopped prematurely because of a defect in the High Pressure Irradiation Loop in the HFR. Several experimental installations were in operation, in particular the 6 MW steam generator test rig and the Neptunus pressurized test unit. Progress was made with the building of a prototype canned-rotor pump, the design of a control-rod drive mechanism and the building of an emergency cooling test installation. (auth)

6068 MAIN COOLANT PUMP MOTOR FAILURE IN THE NS SAVANNAH AND SUBSEQUENT MOTOR REPAIR. Stouky, Roy J. (Nuclear Utility Services, Washington, D. C.); Jackson, E. L. Jr. Trans. Amer. Nucl. Soc., 10: 633–4 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6069 ENERGETICHESKIE USTANOVKI LEDOKOLOV. (Power Plants for Icebreakers). Yudovin, B. S. Leningrad, Izdatel'stvo Sudostroenie, 1967. 240p.

Design, construction and performance of power plants in icebreakers and icebreaker transport ship are discussed. A review is given of the operation of steam and gas turbines, electrical diesels, and nuclear power plants. The economic factors and efficiency of various icebreaker power plants are analyzed. 123 references are included. (R.V.J.)

Rocket and Space Reactors

Refer also to abstracts 4319, 4321–4323, 4345, 4510, and 4813.

6070 (CNLM–5931) PRELIMINARY TITLE I DESIGN REPORT, SNAP-50/SPUR NUCLEAR TEST FACILITY: COMMENTS AND RECOMMENDATIONS. Letter Report. Doll, W. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). Oct. 16, 1964. Contract W-7405-eng-48. 6p. Dep. CFSTI.

The criteria for containment of the SNAP-50/SPUR test facility are discussed. The effects of a maximum credible nuclear accident on the structural design of the test facility are presented. A cost estimate is also presented. (D.C.C.)

6071 EFFECT OF CRYSTALLINE BINDING ON THE AMBIENT AND OPERATING FISSION DISTRIBUTIONS IN HIGH-POWER DENSITY GRAPHITE REACTORS. Sipush, P. J. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 604–5 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6072 RADIANT HEAT TRANSFER IN THE GASEOUS CORE NUCLEAR ROCKET. Williams, J. R.; Clement, J. D. (Georgia Inst. of Tech., Atlanta). Trans. Amer. Nucl. Soc., 10: 423–4 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6073 POWER FLATTENING OF IN-CORE THERMIONIC REACTORS. Disney, R. K.; Miller, L. F.; Ravets, J. M. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 424–5 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6074 EXPERIMENTAL MEASUREMENTS OF PROTON-INDUCED PROMPT SECONDARY GAMMA RAYS. Haffner, J. W.; Beever, E. R.; Rusling, D. H. (North American Aviation, S and ID, Downey, Calif.). Trans. Amer. Nucl. Soc., 10: 425–6 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6075 OPTIMAL SPATIAL DISTRIBUTION FOR MASS SHIELDING AGAINST IONIZING NUCLEAR RADIATION IN SPACE. Liley, Bobby (North American Aviation, S and ID, Downey, Calif.); Duneer, Arthur G. Jr. Trans. Amer. Nucl. Soc., 10: 426–7 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6076 EVALUATION OF SNAP REACTOR DISPOSAL TECHNIQUES. Nelson, D. K.; Detterman, R. L. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 432–3 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6077 SNAP REACTOR ABLATION-DISINTEGRATION EXPERIMENT (RADE) IN A HYPERTHERMAL WIND TUNNEL. Arnold, J. E.; Montgomery, L. D. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 433–4 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6078 ARC-JET ABLATION TESTS ON ZIRCONIUM–URANIUM HYDRIDE SNAP FUEL ELEMENTS. Arnold, J. E.; Barsell, A. W. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 434–5 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6079 PRESSURES AND DENSITIES WITHIN THE EXPANDING SNAPTRAN-2 REACTOR. Moss, L. I.; Rhoades, W. A. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 435–6 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6080 SNAP REACTOR WATER-IMMERSION ACCIDENT PREVENTION THROUGH USE OF GADOLINIUM. Hawley, John P. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 437 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6081 COMPARISON OF CALCULATED AND MEASURED DELAYED- AND PHOTO-NEUTRON DECAY RATE FOR AN NRX REACTOR. Oblock, V.; Woodsum, H. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 413–14 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6082 A COMPARISON OF CALCULATED REACTIVITY FEEDBACK WITH RECENT MEASUREMENTS IN NERVA REACTORS. Ortenberg, L. I. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 414–15 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6083 REACTIVITY MEASUREMENTS AS A NONDESTRUCTIVE TEST OF NERVA FUEL-ELEMENT COMPOSITION. McCutchan, D. A.; Hill, D. J.; Barksdale, C. E. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 415 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6084 FISSIONING NEUTRON FLUX DISTRIBUTIONS IN THE PHOEBUS 1B FACILITY SHIELD. Watson, Clayton W. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 10: 415–16 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6085 STABILITY OF NUCLEAR ROCKET ENGINES. Wiberg, Donald M. (Univ. of California, Los Angeles); Woyski, Jan S. Trans. Amer. Nucl. Soc., 10: 417–18 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6086 CAVITY REACTOR GAS-CORE CRITICAL EXPERIMENT. Masson, L. S. (General Electric Co., Idaho Falls, Idaho); Pincock, G. D.; Kunze, J. F.; Wood, R. E.; Hyland, R. E. Trans. Amer. Nucl. Soc., 10: 419–20 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6087 THE APPLICATION OF A LIQUID REACTIVITY CONTROL SYSTEM TO A LARGE NUCLEAR-ELECTRIC SPACE POWER PLANT. Hampel, Viktor E.; Lee, Joseph D.; Brown, Norman J. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 10: 420-1(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6088 CONTROL METHODS FOR A COMPACT SPACE POWER REACTOR. Kunze, J. F. (General Electric Co., Idaho Falls, Idaho); Sims, F. L.; Reid, R. E. Trans. Amer. Nucl. Soc., 10: 421-2(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 4303, 4432, 4433, 4437, 4511, 4829, 4910, and 5745.

6089 (CEA-R-3213) LES ELEMENTS COMBUSTIBLES DU COEUR DE LA PILE PEGASE: DESCRIPTION, AMELIORATIONS SUCCESSIVES, POSSIBILITES PRESENTES. (Fuel Elements in the Core of the Reactor PEGASE: Description, Successive Improvements, Actual Possibilities). Desandre-Navarre, Christian; Lerouge, Bernard; Schwartz, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). July 1967. 62p. (In French). Dep.

The core of the research reactor PEGASE, in operation at the Cadarache Nuclear Research Centre since 1963, contains fuel elements made from rolled plates of an Al-enriched U alloy whose characteristics have been changed several times. The modifications which have been made to these fuel elements are described with a view both to improving the technical qualities of the reactor and to decreasing its operational costs. Special attention is paid to the neutron aspects of the fuels, and, in particular, to the problem of the long-term modification of the reactivity. (auth)

6090 (EURFNR-395) COMPARISON OF MEASUREMENTS IN SNEAK-1 AND ZPR III-41. Barleon, L.; Boehme, R.; Boehnel, K.; (and others) (Kernforschungszentrum, Karlsruhe (West Germany)). Oct. 1967. 34p. (EUR-3670e; KFK-626; CONF-671043-2). Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

From Symposium on Fast Reactor Physics and Related Safety Problems, Karlsruhe, Germany.

Data for critical mass measurements, prompt neutron decay constants, flux profiles, and fission ratios are presented and compared for the SNEAK-1 and the ZPR III-41 reactors. (D.C.C.)

6091 (EURFNR-396) PHYSICS INVESTIGATIONS OF A 670 l STEAM COOLED FAST REACTOR SYSTEM IN SNEAK, ASSEMBLY 3A-1. Barleon, L.; Bayer, A.; Boehme, R.; (and others) (Kernforschungszentrum, Karlsruhe (West Germany)). Oct. 1967. 45p. (EUR-3671e; KFK-627; CONF-671043-3). Dep. CFSTI.

Work performed under United States – Euratom Fast Reactor Exchange Program.

From Symposium on Fast Reactor Physics and Related Safety Problems, Karlsruhe, Germany.

A series of experiments is under way at the Karlsruhe Fast Zero Power Reactor SNEAK for the investigation of steam cooled fast reactors in the 100 MW(e) range. The critical experiment of SNEAK 3A-1, a 670 liter uranium system containing 7.41×10^{20} atoms/cm^3 of hydrogen in the form of polyethylene foils, has been started. The neutron physics of this assembly has been studied in detail. The neutron energy spectrum has been measured by various methods from the eV-region to over 1 MeV in the core center and at the periphery, reaction rates have been measured in the center and in axial and radial traverses, the initial breeding ratio and the reactivity worth of selected materials have been determined. Measurements of the Doppler reactivity effect, the steam void effect and of β/l have been performed. Special effort was devoted to the experimental investigation of heterogeneity effects. The experimental results are compared with calculations using the 26 group ABN set and a specially prepared 26 group cross section set KFK-SNEAK using latest cross section information and the SNEAK-3A spectrum as a weighting spectrum. The heterogeneity results are compared with theoretical models including space dependent resonance self-shielding. (auth)

6092 (EURFNR-397) THE GROUP CROSS-SECTION SET KFK-SNEAK: PREPARATION AND RESULTS. Bachmann, H.; Huschke, H.; Kiefhaber, E.; Krieg, B.; Kuesters, H.; Metzenroth, M.; Siep, I.; Wagner, K.; Woll, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Oct. 1967. 27p. (EUR-3672e; KFK-628; CONF-671043-1). Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

From Symposium on Fast Reactor Physics and Related Safety Problems, Karlsruhe, Germany.

Methods used in calculating infinite dilute group constants are presented. A comparison of the main differences in the basic data is shown. During the preparation of the group constant set the influence of the data on integral quantities for SNEAK 3A-2 is studied. (D.C.C.)

6093 (EURFNR-401) OPERATIONAL CHARACTERISTICS AND RELATED DESIGN FEATURES OF SNEAK. Bickel, W.; Engelmann, P.; Walze, H.; Wittek, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Oct. 1967. 28p. (EUR-3676e; KFK-632; CONF-671043-4). Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

From Symposium on Fast Reactor Physics and Related Safety Problems, Karlsruhe, Germany.

A description of the fast zero power SNEAK reactor is presented. Details of instrumentation and control and the operational characteristics of the reactor are presented. (D.C.C.)

6094 (EURFNR-403) GERMAN FAST BREEDER PROGRAM. Haefele, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Oct. 1967. 15p. (EUR-3678e; KFK-634; CONF-671043-6). Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

From Symposium on Fast Reactor Physics and Related Safety Problems, Karlsruhe, Germany.

A description of the German fast breeder reactor program is presented. Experimental facilities described for the program include: pulsed subcritical SUAK assembly; STARK; fast zero power SNEAK; 20 MW(t) SEFOR test reactor; and KRITO thermal critical facility. (D.C.C.)

6095 (IDO-17245) SPERT PROJECT QUARTERLY TECHNICAL REPORT, OCTOBER–DECEMBER 1966. Taxelius, T. G. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Oct. 1967. Contract AT(10-1)-205. 40p. Dep. CFSTI.

Topics discussed include: the Spert-3 oxide core kinetics program with transient tests at low initial power and criticality shift analysis in the E-core; the Spert-4 capsule driver core subassembly test program with mechanical energy generation from fuel rod failure and fuel temperature measurements; and the Power Burst Facility with in-pile fuel testing of phase stability. (D.C.C.)

6096 (IN-1143) USE OF THE ARMF FOR A FAST REACTOR SUPPORT PROGRAM. Fast, E.; Beck, C. L.; Millsap, D. A.; Nisle, R. G.; Rogers, J. W.; Scoville, J. J. (Idaho Nuclear Corp., Idaho Falls). Nov. 1967. Contract AT(10-1)-1230. 66p. Dep. CFSTI.

Calculations show that flux spectra approximating those of fast reactors can be generated in a relatively small region in the center of the ARMF. Adequate sensitivity is available for making reactivity measurements of the usual small samples. The proposed concept also permits component parts of the fast flux core to be varied, thus producing a range of spectra. Irradiated specimens may be handled with a hot sample changer presently being used with a Cd shielded facility. Specimens may be irradiated in an intense fast flux environment in a flux converter-thermal filter capsule in the MTR or ETR. A simple converter tube facility with a UO_2 shielded sample volume was used to obtain preliminary measurements for comparison with calculations. Reactivity values were obtained with 17 specimens, mostly metals, including stainless steels and natural uranium. A 26-group one-dimensional diffusion code gave results that were in reasonable agreement with experiment in most cases. A proton-recoil spectrometer has been built for measurement of the KeV-MeV neutron energy spectrum providing independent information to check calculations. (auth)

6097 (PINSTECH/PHY-7) NEUTRON FLUX MEASUREMENTS IN THE EXPERIMENTAL FACILITIES OF THE PAKISTAN RESEARCH REACTOR. Qazi, Muhammad Nuruddin; Solaija, Tariq Jamal; Nuruddin, Azra; Khan, Hameed Ahmed (Pakistan Inst. of Nuclear Science and Technology, Islamabad. Nuclear Physics Div.). 1967. 12p. Dep.

Neutron flux has been measured in the various experimental facilities of the Pakistan Research Reactor using gold as the activation detector. A calibrated G.M. system has been used to deduce the absolute values of the neutron flux. The results are presented with a brief description of the experimental facilities. (auth)

6098 (PINSTECH/RO–1) INITIAL START-UP OF THE PAKISTAN RESEARCH REACTOR. (Pakistan Inst. of Nuclear Science and Technology, Islamabad. Reactor Operation and Maintenance Div.). 1966. 15p. Dep.

The Research Reactor of Pakistan (PARR) is a swimming pool type, fuelled with 90% enriched Al–U alloy using demineralized water as moderator, coolant, reflector and shielding material. The reactor is designed to operate at a maximum power of 5 MW(t). The reactor was initially made critical in the open pool with 3025.27 grams of ^{235}U, keeping three shim safety rods and a regulating rod. Six additional core configurations were studied with five shim safety rods. The results are presented. (auth)

6099 (TUBIK–5) BESTIMMUNG REAKTORKINETISCHER KENNGROESSEN AM SUR 100 BE MIT DETERMINIERTEN UND STOCHASTISCHEN SIGNALEN. (Estimation of Reactor Kinetics Magnitudes in the SUR 100 BE by Fixed and Stochastic Signals). Moritz, U.; Vierke, H.; Wesser, U.; Wolf, L.; Zeisset, W. (Technische Universitaet, Berlin (West Germany). Institut fuer Kerntechnik). May 1967. 346p. (In German). Dep.

Linear reactor kinetics describe the time behavior of a reaction-free zero power reactor such as the SUR-100-BE. It was shown that the analytical and the experimental investigations which use fixed and stochastic signals are equivalent, but the latter has some advantages in practice. Beginning with the transport theory, the kinetic reactor equations for average neutron densities were derived and their applicability for different reactor kinetic studies was indicated. With the help of an expanded signal theory, based on the information theory, fixed and stochastic signals were connected. On the basis of the characteristic of the stochastic signal the possibility of their practical introduction is given. They also lead in the analytical consideration to an expanded understanding of the processes occurring in the system. The mathematical analysis leads to a transport equation which is soluble for binary densities. This contains the complete information for the process model of the Markoff processes so that the correlation methods give more information than the conventional methods. Since the transport equation for average densities is a special case of this general method, the input signals were subjected to an evaluation with respect to their information content. Therefore it is possible to derive a system theory and to control problems from a new viewpoint. (tr-auth)

6100 GEOMETRY PROBLEMS ENCOUNTERED WITH THE FAST-FLUX TEST FACILITY (FFTF) SPLIT CONICAL CORE. Waymire, G. R.; Peterson, R. E.; Finch, L. M. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 646-8 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6101 MEASUREMENTS OF NEUTRON ENERGY SPECTRA IN A ZERO-POWER FAST REACTOR USING THE TIME-OF-FLIGHT AND PROTON-RECOIL METHODS. Benjamin, P. W.; Patterson, W. J.; Weale, J. W. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). Trans. Amer. Nucl. Soc., 10: 576 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6102 APPLICATION OF A THEORETICAL MODEL FOR INTERPRETING OBSERVED SPECTRAL DENSITY OF POWER FLUCTUATIONS IN WATER REACTORS. Robinson, J. C.; Fry, D. N. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 590-1 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6103 ^{233}U–Th SEED-BLANKET CRITICAL EXPERIMENTS. Milani, S. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 595 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6104 REACTOR PHYSICS PARAMETERS OF $^{233}UO_2$–ThO_2 LATTICES IN D_2O. Windsor, Henry H.; Tunney, William J. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 595-6 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6105 ANALYSES OF BROOKHAVEN ^{233}U–^{232}Th OXIDE, LIGHT- AND HEAVY-WATER-MODERATED LATTICE EXPERIMENTS. Sehgal, Bal Raj (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 596-7 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6106 VIPER, A VERSATILE PULSED REACTOR USING DOPPLER AND EXPANSION SHUTDOWN. Long, R. L.; McTaggart, M. H.; Weale, J. W. (Atomic Energy Research Establishment, Aldermaston, Eng.). Trans. Amer. Nucl. Soc., 10: 608-9 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6107 DESIGN AND METALLURGICAL ASPECTS OF THE ARMY PULSED RADIATION FACILITY REACTOR. Lundin, M. L.; Litman, A. P.; Leonard, W. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 609-11 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6108 SUPERPROMPT CRITICAL BEHAVIOR OF A URANIUM–MOLYBDENUM ASSEMBLY. Mihalczo, J. T. (Oak Ridge National Lab., Tenn.); Lynn, J. J.; Watson, J. E.; Dickinson, R. W. Trans. Amer. Nucl. Soc., 10: 611-12 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6109 DYNAMIC MECHANICAL MEASUREMENTS ON THE ARMY PULSED REACTOR. Reuscher, J. A. (Sandia Corp., Albuquerque, N. Mex.); Richter, J. M. Trans. Amer. Nucl. Soc., 10: 612 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6110 IMPORTANCE-SHAPE METHOD FOR DETERMINING THE BUCKLING IN A REFLECTED REACTOR. Greenspan, Ehud (Rensselaer Polytechnic Inst., Troy, N. Y.); Shaw, Robert A. Trans. Amer. Nucl. Soc., 10: 605-6 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6111 APPLICABILITY OF PULSED-SOURCE TECHNIQUES TO VERY FAR SUBCRITICAL ASSEMBLIES. Simmons, G. M.; Gozani, T.; Jupiter, C. P.; Preskitt, C. A. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 624-5 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6112 DETERMINATION OF REACTIVITIES USING PULSED-NEUTRON TECHNIQUES FOR HIGHLY SUBCRITICAL SOLUTION REACTORS. Fieno, Daniel; Fox, Thomas A.; Mueller, Robert A.; Ford, C. Hubbard (Lewis Research Center, Cleveland). Trans. Amer. Nucl. Soc., 10: 625-6 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6113 ANALYSIS OF SOME ^{235}U-GRAPHITE CRITICAL EXPERIMENTS. Sehgal, Bal Raj (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 535-6 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6114 STUDIES OF CRITICAL ASSEMBLIES OF HOMOGENEOUS MIXTURES OF PLUTONIUM OXIDE AND POLYSTYRENE. Baxter, Alan M. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Clayton, E. D.; Hansen, L. E. Trans. Amer. Nucl. Soc., 10: 536 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6115 CRITICAL EXPERIMENTS WITH PHOENIX FUEL IN AN MTR MOCKUP. Smith, R. I.; Davis, E. C. Jr.; Williams, L. D. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 537 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6116 ACTIVATION SHAPES IN ^{233}U- AND ^{235}U-THORIUM SEED-BLANKET CRITICAL ASSEMBLIES. Weiss, S. H.; Lehmann, P. H.; Mitchell, J. A.; Johnson, P. J.; Russell, C. D.; Wheat, L. L. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 537-8 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6117 CRITICALITY OF ^{233}U AQUEOUS NITRATE SOLUTION IN REFLECTED AND UNREFLECTED ARRAYS. Thomas, J. T. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 538-9 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6118 THE NUCLEAR SAFETY OF AQUEOUS SOLUTIONS OF ^{233}U AND ^{235}U. Webster, J. Wallace (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 539(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6119 MINIMUM CRITICAL ^{235}U ENRICHMENT FOR URANYL NITRATE HYDROGENOUS SYSTEMS. Bierman, S. R.; Hess, G. M. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 539-40(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6120 COMPARISON OF MEASURED AND MONTE CARLO CALCULATED GAMMA DOSE IN THE TUNGSTEN WATER-MODERATED CRITICAL ASSEMBLY. Paulson, Walter A.; Klann, Paul G. (Lewis Research Center, Cleveland). Trans. Amer. Nucl. Soc., 10: 545(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6121 ANALYSIS OF FTR CONTROL-ROD EXPERIMENTS PERFORMED IN ZPR-3 ASSEMBLY 48 AND 48A. Engstrom, S. L.; Bennett, R. A. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 528-9(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6122 DISCRETE-ORDINATE TRANSPORT-THEORY CALCULATIONS ON THE EFFECT OF HETEROGENEITIES ON REACTIVITY IN ZPR-3 ASSEMBLY 48. Edison, G. E.; Bennett, L. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 529-30(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6123 A COMPARISON OF CALCULATION AND EXPERIMENT FOR ZPR-3 ASSEMBLY 48. Pitterle, T. A. (Atomic Power Development Associates, Inc., Detroit); Yamamoto, M. Trans. Amer. Nucl. Soc., 10: 530-1(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6124 PLUTONIUM FUEL IRRADIATIONS IN PRTR: PRESENT STATUS. Freshley, M. D.; Burley, T. B.; Goldsmith, S. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 518-19(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6125 POWER TESTS WITH THE UO_2–2 WT PERCENT PuO_2 BATCH CORE IN THE PRTR. Kutcher, J. W.; Harris, R. E.; Smith, R. I. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 517-18(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6126 UTILIZATION OF THE REACTOR BR2. Bobin, J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Nucl. Eng., 12: 829-32(Nov. 1967).
Experience in the operation of the pressurized-water high-flux materials-testing reactor is outlined. Problems encountered in the management of the internationally sponsored irradiation programmes are reviewed. Further development potential of the reactor is considered. (UK)

6127 FABRICATION OF JRR-2 FUEL ELEMENT. Yamamoto, Tatsuro (Furukawa Electric Co., Ltd., Japan). Genshiryoku Kogyo, 13: No. 2, 33-7(Feb. 1967). (In Japanese).
In JRR-2 fuel elements of the MTR type are used. This type of fuel element contains 90% enriched U and is subjected to high neutron and heat fluxes, and so it is necessary that the method of fabrication have good quality control. The fuel elements for JRR-2 have been imported from the United States, but recently it was decided to use domestic ones starting from the sixth fuel charge. A description is made of the fabrication of the JRR-2 type fuel element and a hollow fuel element as the future JRR-2 fuel in the following sections: the fuel element; the methods of fabrication (fuel material, fuel plate, JRR-2 type fuel element, and a hollow fuel element); test and inspection (inspection of the uranium content in the fuel material, foam test, x-ray penetration test, etc.); and uranium handling in the course of fabrication (reactivity control and weight control). (NSA of Japan)

6128 FAST CRITICAL ASSEMBLY (FCA). Hirota, Jitsuya (Japan Atomic Energy Res. Inst., Tokyo). Genshiryoku Kogyo, 13: No. 7, 23-7(July 1967). (In Japanese).
The Fast Critical Assembly (FCA), of Japan Atomic Energy Research Institute, went critical on April 29, 1967. It is of the type divided into two halves horizontally and is also provided with a pulsed-neutron generator. The construction, characteristic features, and safety are described. (TSS) (NSA of Japan)

6129 HIGH-TEMPERATURE SUBCRITICAL ASSEMBLY IN OSAKA UNIVERSITY. Goto, Hajime (Meidensha Electric Mfg. Co., Ltd., Tokyo); Sumiia, Kenji. Meidensha Jiho, No. 73, 17-24(Apr. 1967). (In Japanese).
The high-temperature subcritical assembly in Osaka University was designed and constructed as a tool for the basic research on the development of nuclear power generation, and it will be used for the high-temperature, reactor physics and engineering studies of a relatively small, graphite-moderated multiplication system. The assembly was constructed in association with an ordinary-temperature, exponential experiment facility, and consists of a cube, made up by arrangement of 100-mm square and 1,000 mm long graphite blocks in 10 rows and 10 layers; experimental fuel rods can be inserted at intervals of 100 mm. The temperature is designed to be up to 2,000°C, considering the future research of MHD power generation and a preliminary research of the nuclear power for rockets. The coolant is a He gas, which is chemically inactive. The heating is done by the use of the existing 250 kVa diesel dynamo with graphite-electrode dc heating. The assembly has been tested up to the temperature of 1,400°C, showing the good result in the internal temperature distribution and in the constant temperature control, and basic information obtained for the future increase up to 2,000°C. The construction of the assembly, the development and research performed prior to the design, the operation and test of the assembly, and the results of tests are described. (NSA of Japan)

6130 DOSE RATE EQUIVALENTS OF INTERMEDIATE-ENERGY NEUTRONS IN THE ENVIRONMENT OF THE WWR-S REACTOR. Makra, S. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 15: 271-81(1967). (In Hungarian).
The determination of neutron dose equivalent rates for slow, intermediate and fast neutrons as well as of the average energy measurements in the environment of the Hungarian WWR-S reactor are reported. The measurements were performed at different areas of the annular shield and at the top of the reactor. The measured data show that the dose rate equivalents on the top shield are, on the average, of the order of 1 mrem/hr but may exceed 10 mrem/hr close to the outlet of the ventilation ducts, while at the annular shield the dose rate equivalent remains, as a rule, below 0.2 mrem/hr. The number of intermediate neutrons was 90 to 95% of the total dose equivalent and the contribution of the thermal neutrons did not exceed 1%. (auth)

6131 CHARACTERISTICS OF THE UTR-100 REACTOR. Izatt, J. A.; Scobie, J. (Scottish Research Reactor Center, East Kilbride). J. Brit. Nucl. Energy Soc., 6: 343-53(Oct. 1967).
Results are presented of a series of measurements of physics and engineering parameters on the UTR-100 (Argonaut type) reactor at the Scottish Research Reactor Centre. A brief survey is made of operating experience with this university reactor during its first four years in service. (auth)

6132 QUALITATIVE ANALYSIS OF THE RADIOACTIVE SUBSTANCES IN THE COOLING WATER OF THE HUNGARIAN VVR-S REACTOR. Schneer, D.; Csada, I.; Szabo, E. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 14: 245-58(1966). (In Hungarian).
A simple method has been developed for the identification of the short-lived isotopes ^{64}Cu, ^{56}Mn, and ^{24}Na present in the cooling water circulating in the reactor core. The long-lived isotopes ^{60}Co, ^{51}Cr, ^{54}Mn, ^{124}Sb, ^{113}Sn, and ^{65}Zn had to be separated first from the water by precipitation or by paper chromatography, then identified by gamma spectrometry. For Al^{3+} and Cu^{2+} ions the analysis could be performed by chemical methods after their separation by paper chromatography. (auth)

6133 NEUTRON CONVERTERS FOR DMTR. Hendry, I. C. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Nucl. Eng., 12: 832-7(Nov. 1967).
In order to increase the number of fission flux facilities, neutron converters were designed for insertion in the reflectors. Three designs are described, and preliminary data are given for a fourth design. Operating data for the converters are given and experience is summarized. (UK)

6134 LIQUID EXCURSION PULSED REACTOR. King, L. D. Percival (to U. S. Atomic Energy Commission). U. S. Patent 3,359,173. Dec. 19, 1967.
A liquid pulsed neutron source contained in a cavity is described. The liquid fuel is supercritical and is propelled with such velocity that the fuel maintains its geometry until it reaches the center portion of the cavity. The walls of the cavity are cooled. (AEC)

Reactor Theory, Components, Fuels, and Accessories

Refer also to abstracts 4130, 4131, 4317, 4401, 4402, 4440, 4505, 4509, 4561, 4728, 4730, 4739, 4759, 4802, 4823, 4826, 4827, 4830, 4831, 4856, 4868, 4871, 4877, 4880, 4907, 4909, 4913, 4914, 5711, and 5818.

6135 (BNWL-625) GAMMA HEATING CALCULATIONS IN GRAPHITE MODERATED SYSTEMS. Hanson, G. E.; Busselman, G. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1, 1967. Contract AT(45-1)-1830. 20p. Dep. CFSTI.

Calculations were carried out to determine the amount of fission product gamma ray energy absorbed in various regions of a tubular fuel element and the surrounding graphite of a unit cell. Two different methods were used, involving two separate computer codes; a point-kernel shielding code and a transport code. Several approximations of the annular fuel element were used in the shielding code. Results from the two methods are compared and discussed, and the best approximation using the simpler shielding code is determined. (auth)

6136 (BNWL-SA-1377) CONTROLLED TEMPERATURE-PRESSURE IRRADIATION CAPSULES. Hann, C. R.; Marshall, R. K.; Leggett, R. D.; Pilger, J. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 25, 1967. Contract AT(45-1)-1830. 23p. (CONF-671102-35). Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

Description of a temperature, pressure controlled capsule for uranium swelling studies is presented. Thermal flux profiles for several controlled temperature-pressure irradiation capsules are also presented. (D.C.C.)

6137 (CONF-670431) 7. FACHTAGUNG DES DEUTSCHEN ATOMFORUMS e.V. "REAKTORTHEORIE". (Seventh Technical Meeting of the Deutsches Atomforum e.V. "Reactor Theory"). (Mainz Univ. (West Germany)). 1967. 100p. (In German). Dep.

Abstracts of the papers presented at the Seventh Technical Meeting are compiled. The topics discussed were calculation of fast and thermal reactors, theory of heterogeneous reactors, reactor shielding, transport theory, short- and long-time behavior of reactors, theoretical analysis of experimental methods and results, and mathematical methods. The complete text of one paper was presented: "Boundary Conditions for the Neutron Flux in the Cylinderizing of Hexagonal and Quadratic Cells". For preparation of S_n calculation with the Winfrith S_n program, the effect of cylinderization of a hexagonal or quadratic cell in combination with the boundary condition "white" must be considered. The size of the effect and the methods to correct errors in $\bar{\phi}_1/\bar{\phi}_0$ must be determined. A theoretical analysis led to the conclusion that cylinderization leads to too small a value of $\bar{\phi}_1/\bar{\phi}_0$. The error lies between 0 and 8%. The effect is larger for quadratic cross sections than for hexagonal cross sections. Cylinderization in combination with "reflecting" boundary conditions leads to too large a value of $\bar{\phi}_1/\bar{\phi}_0$. The use of a mixed "white-reflecting" boundary condition in S_n calculations give better result. (J.S.R.)

6138 (LA-3820) QUARTERLY STATUS REPORT ON THE ADVANCED PLUTONIUM FUELS PROGRAM, JULY 1-SEPTEMBER 30, 1967. (Los Alamos Scientific Lab., N. Mex.). Nov. 14, 1967. Contract W-7405-eng-36. 42p. Dep. CFSTI.

The release and distribution of fuel and fission products in sodium systems were studied using both sealed capsules and forced-connection sodium loops. The solubility of oxygen in sodium using the vacuum-distillation analytical technique was determined over the temperature range of 125 to 300°C. Experimental facilities to be used in the development of analytical techniques for the measurement of impurities in sodium and a sodium loop to study the performance characteristics of different designs of cold traps were constructed. Several tests were conducted to determine the rates of change of oxygen concentration in the sodium loop following rapid changes in the cold-trap temperature. Studies were continued on the synthesis, fabrication, and determination of high temperature properties of plutonium and uranium carbide and oxide fuel materials. Results in the program to determine the interactions of (U,Pu)C and (U,Pu)N fuels with sodium and potential cladding materials in order to achieve a satisfactory sodium-bonded fuel element are presented. Progress is reported on the nuclear analysis and evaluation of various fast breeder concepts and proposals and on the development of evaluated cross-section data and processing codes. The development of equipment and methods to be used in the examination and comparison of neutron irradiation effects on LMFBR Program fuel materials is summarized. (H.D.R.)

6139 POSSIBILITY OF THE EXISTENCE OF A NUMBER OF STATIONARY NEUTRON DISTRIBUTIONS IN A NUCLEAR POWER REACTOR. Moskalev, O. B. Zh. Vychisl. Mat. Mat. Fiz., 7: 920-3(July-Aug. 1967). (In Russian).

The stationary neutron distributions are found for a simple reactor model, in which the power reactivity coefficient is positive with a decrease in reactivity due to poisoning by ^{135}Xe. On the basis of this model it can be shown that there are two positive solutions of the stationary neutron diffusion equations. (Actually there are three solutions, but the third solution will not be discussed because of the very high temperatures required within the reactor.) Thus a number of stationary neutron distributions can exist in a reactor with unchanged positions of the fuel and regulating rods. Due to various effects relating the power and reactivity of a reactor, the critical reactor power can assume a number of values with unchanged position of the regulating rods. If the reactivity of a cold unpoisoned reactor is too great, there is no stationary neutron distribution. At a certain reactivity existing between certain limits, two different stationary neutron distributions can exist in the reactor. Finally with a small reactivity only one neutron distribution is possible. (TTT)

6140 PEAK HEAT-FLUX FACTOR DEPENDENCE UPON FUEL-ELEMENT FABRICATION PARAMETERS. Grillo, Paolo; Testa, Gabriele (CNEN, Trieste, Italy). Trans. Amer. Nucl. Soc., 10: 653-4(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

6141 IN-PILE PERFORMANCE OF VENTED MIXED-OXIDE FUEL IN FLOWING LIQUID METAL. Gregoire, Keith E.; Novak, Philip E. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 10: 662(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

6142 MEASUREMENTS OF INTERNAL DAMPING OF REACTOR FUEL-ELEMENT MATERIALS. Margolis, Stephen G.; Krenz, Robert A. (State Univ. of New York, Buffalo). Trans. Amer. Nucl. Soc., 10: 662-3(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

6143 ELASTIC ANALYSIS OF THERMAL-GRADIENT BOWING IN ROD-TYPE FUEL ELEMENTS SUBJECTED TO AXIAL THRUST. Newman, John B. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 663-4 (Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

6144 RESPONSE OF AXIALLY RESTRAINED PELLET FUEL TO TRANSIENT OVERPOWER. Thomas, Garry R.; Field, John H. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 10: 707-9(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

6145 ANALYTIC SOLUTION OF THE TIME LINEARIZED KINETIC EQUATIONS OF MULTIREGION REACTORS IN THE DIFFUSION APPROXIMATION. Bobone, Renato (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 10: 568-9(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

6146 TIME SYNTHESIS: A STUDY OF SYNTHESIS MODES AND WEIGHTING FUNCTIONS. Rydin, R. A. (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 10: 569-70(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

6147 OPTIMUM BIASING FUNCTIONS APPLIED TO MONTE CARLO CALCULATIONS. Lilley, John R. (Douglas Aircraft Co., Inc., Santa Monica, Calif.). Trans. Amer. Nucl. Soc., 10: 600-1(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

6148 MONTE CARLO INTEGRATION OF THE ADJOINT GAMMA-RAY TRANSPORT EQUATION. Kalos, M. H. (New York Univ., N. Y.). Trans. Amer. Nucl. Soc., 10: 601(Nov. 1967).

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5-9, 1967. See CONF-671102.

6149 NUMERICAL SOLUTIONS OF THE ONE-SPEED ALBEDO AND CRITICAL SLAB PROBLEMS BY THE TRANSFER

MATRIX METHOD. Caroll, Gerhard; Aronson, Raphael (New York Univ., N. Y.). Trans. Amer. Nucl. Soc., 10: 606(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6150 THEORIES OF REACTOR FLUX OPTIMIZATION. Mingle, J. O. (Kansas State Univ., Manhattan). Trans. Amer. Nucl. Soc., 10: 602-3(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6151 USE OF MULTIDIMENSIONAL LEAST-SQUARES TECHNIQUES IN REACTOR PARAMETRIC STUDIES. Sawyer, C. D.; Hill, P. R. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 10: 603-4(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6152 P_L BLACKNESS THEORY IN PLANE GEOMETRY. Congdon, S. P.; Mendelson, M. R. (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 10: 546(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6153 DOUBLE SPHERICAL HARMONICS APPROXIMATION FOR CYLINDRICAL GEOMETRY. Wang, Chi Chang; Maynard, Charles W. (Univ. of Wisconsin, Madison). Trans. Amer. Nucl. Soc., 10: 546-7(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6154 POLYNOMIAL FLUX APPROXIMATIONS IN INTEGRAL TRANSPORT THEORY. Lewis, E. E. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 10: 547-8(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6155 THE METHOD OF SOLUTION-FUNCTIONS EXTENDED FROM ρ-θ TO ρ-z AND ρ-θ-z GEOMETRY. Bobone, Renato (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 10: 548-9(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6156 EXISTENCE THEOREMS FOR THE DISCRETE FORM OF THE MULTIGROUP DIFFUSION EQUATIONS. Froehlich, Reimar (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 549-50(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6157 SEMIDIRECT LEAST-SQUARES VARIATIONAL METHODS AND INITIAL-VALUE PROBLEMS. Becker, Martin (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 10: 550-1(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6158 TRANSPORT EFFECTS IN DIFFUSION THEORY. Calame, Gerald P.; Sisk, Arnold J. (US Naval Academy, Annapolis, Md.). Trans. Amer. Nucl. Soc., 10: 551(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6159 TIME MOMENTS IN SPACE-TIME NEUTRON SLOWING DOWN. Diamond, David J.; Yip, Sidney; Clikeman, Franklyn; Beghian, Leon (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 10: 551-2(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6160 SPATIALLY DEPENDENT SLOWING DOWN CALCULATIONS FOR HYDROGEN. Amster, H. J. (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc., 10: 552-3(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6161 NORMAL-MODE EXPANSION TECHNIQUE IN SPHERICAL GEOMETRY. Siewert, G. E. (North Carolina State Coll., Raleigh). Trans. Amer. Nucl. Soc., 10: 553-4(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6162 DIRECT IN-PILE MEASUREMENT OF THE CENTRAL TEMPERATURE OF A SODIUM-BONDED MIXED OXIDE FUEL PIN. Plumlee, Donald E.; Novak, Philip E. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 10: 639(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6163 BRANCHING PROCESSES AND REACTOR THEORY. Cook, J. M. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 521(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6164 NUCLEAR FUEL TESTS. Lyons, Mark F. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 10: 501(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6165 INTRODUCTORY REACTOR PHYSICS: USE OF A DIGITAL COMPUTER IN PROBLEM SOLVING. Bregar, John F. (Arizona State Univ., Tempe). Trans. Amer. Nucl. Soc., 10: 439(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6166 ENGINEERING ECONOMY IN NUCLEAR-FUEL COST EVALUATIONS. Craig, Thomas W. (Univ. of Michigan, Ann Arbor); Fulford, P. J.; Swanson, Richard. Trans. Amer. Nucl. Soc., 10: 438(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6167 NEUTRON KINETICS OF A CYLINDRICAL-CAVITY REACTOR. Podney, Walter N.; Smith, Harold P. Jr. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 10: 422-3(Nov. 1967).
From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill., Nov. 5–9, 1967. See CONF-671102.

6168 RESEARCH ON THE LONG-RANGE OPTIMIZATION OF REACTOR STRATEGIES IN CONSIDERATION OF THE EXTENT OF URANIUM RESERVES. PART I. DESCRIPTION OF THE OPTIMAL MODEL. Maerki, H. (Siemens AG, Erlangen, Ger.). Nukleonik, 10: 207-17(1967). (In German).
An optimal model for investigation of the problems of long-range optimal use of nuclear fuel reserves, based on use of linear programming methods for economic criteria, is derived. Results of research efforts will be given in Part 2. (tr-auth)

6169 IN-PILE CALORIMETRIC DOSIMETRY. II. Ohno, Ketichi (Hokkaido Univ., Jap.); Hayakawa, Sohachiro. J. Nucl. Sci. Technol. (Tokyo), 4: 555-9(Nov. 1967).
An in-pile calorimeter of twin-rod conduction type has been developed for measuring simultaneously neutron-induced and γ-induced energies. Calorimetric measurements with the apparatus were carried out in the horizontal experimental hole of JRR-1 (water boiler reactor) at a position 41.5 cm from the core edge. The thermal neutron flux was 4.55×10^{11} n/cm^2·sec at 40 kW reactor power. The rates of γ-induced and neutron-induced energies per unit mass of polyethylene were 2.72(mW/g) and 1.04(mW/g) respectively. These measured data were reasonably consistent with the values obtained with adiabatic calorimeter. (auth)

6170 A SIMPLE METHOD OF CALCULATING THE ^{238}U FISSIONS IN ISOLATED, LOW-ENRICHED URANIUM RODS. Murley, T. E. (Westinghouse Advanced Reactors Div., Pittsburgh); Kaplan, I. Nukleonik, 10: 177-80(Oct. 1967).
A method is presented for calculating the fast fission effect in isolated, low-enriched uranium rods. The basis of the method is a direct calculation of the spatial and energy distribution of the collision groups of fission neutrons after one, two, three, ... etc., collisions in the fuel rod. The calculation uses recent data on ^{238}U inelastic scattering above the fission threshold. The resulting expression for ϵ is an easily calculated series of terms, each of which has a direct physical interpretation and which involves the enrichment and escape probabilities from the rod. Calculations are presented for the case of 1 per cent enriched rods ranging from 0.635 to 10.16 cm in diameter. The results are in excellent agreement with measurements made in the graphite-lined cavity of the MIT Heavy Water Lattice Facility. The results presented here are in a form that can be used directly in less rigorous formulations which, however, also include the effect of backscattering from the moderator and for the interaction between rods in a lattice. (auth)

6171 PERTURBATION METHOD OF ANALYSIS APPLIED TO SUBSTITUTION MEASUREMENTS OF BUCKLING. Persson, R. (AB Atomenergie, Studsvik, Sweden). Nukleonik, 10: 163-77(Oct. 1967).
Calculations with two-group perturbation theory on substitution experiments with homogenized regions show that a condensation of the results into a one-group formula is possible, provided that a transition region is introduced in a proper way. In heterogeneous cores the transition region comes in as a consequence of an uncon-

ventional cell concept, where the fuel elements are situated in the corners of the cells. By making use of progressive substitutions the properties of the transition region can be regarded as fitting parameters in the evaluation procedure. Diffusion coefficients are allowed to depend on direction and position. From single-element perturbation experiments differences between diffusion coefficients can be determined. Experiments on rod lattices in D_2O and on test regions of D_2O alone (where $B^2 = -1/L^2$) are analyzed. The lattice measurements, where the pitches differed by a factor of $\sqrt{2}$, gave excellent results whereas the determination of the diffusion length in D_2O by this method was not quite successful. Even regions containing only one test element can be used in a meaningful way in the analysis. (auth)

6172 ON THE MEASUREMENT OF α BY A SIMPLE DEAD TIME METHOD. Srinivasan, M. (Bhabha Atomic Research Centre, Bombay). Nukleonik, 10: 224-5(Oct. 1967).

The equations for the derivation of Rossi α or the prompt neutron decay constant from measuring the count rate after the dead time filter as a function of the dead time introduced are presented. (D.C.C.)

6173 DELAY-TIME DISTRIBUTION FUNCTION IN COUPLED REACTOR KINETICS. Belleni-Morante, A. (Univ., Florence). Nukleonik, 10: 217-23(Oct, 1967).

The kinetic equations of a reactor composed of two loosely coupled cores were derived directly from a modified form of the transport equation. The existence of a delay time distribution function due to the energy distribution of interaction neutrons is proved. (auth)

6174 STUDY ON THE HIGH-STRESS FATIGUES OF REACTOR PRESSURE VESSELS WITH VARIOUS NOZZLE CONFIGURATIONS. Kameoka, Toshio; Sato, Eiichi (Kobe Steel Ltd., Japan). Kobe Seiko Gijo, 16: No. 4, 277-90(Nov. 1966). (In Japanese).

The results are described of the experimental study to determine the low-cycle fatigue characteristics of pressure vessels having various nozzle configurations. Nozzle strengths: Among the configurational factors influencing the nozzle fatigue strength are the value of d/D, the amount of protrusion and the fillet radius. The larger these values, the higher becomes the strength. Strains at the nozzle-corner: (When the strain was pursued until just before breakage with a strain gage) the residual strain advances with repetition of the pressure; and both the elongation and the strain at breakage are small. The residual strain is increased as the pressure vessel is subjected to a higher pressure. Fractured suface: Fatigue surface is shown only at the outset of cracks, and brittle surface predominates. (NSA of Japan)

6175 TURBULENT HEAT CONDUCTION EXPERIMENT IN A PIPE WITH AN AXIAL VARIATION OF THE HEAT FLUX. Kuga, Osamu. Nippon Kikai Gakkai Rombunshu, 32: No. 242, 1535-40(Oct. 1966). (In Japanese).

The results of turbulent heat-conduction experiments in a pipe in which the heat flux can be changed in the axial direction are presented. The flow is considered as appropriate for the experiments due to 54 diameter non-heating distance. An experiment was made on the uniform heat flux, and the precision of the experimental apparatus was confirmed by comparing with other results. The results of the sin-shape heat flux were compared with Aoki's, and lastly those of the strain sin-shape heat flux were compared. In the case of the uniform heat flux, the change of the sectional Nusselt's number with the axial distance, and the value of the asymptotic Nusselt's number agreed with the results by other workers. The results of sin-shape heat flux were in accordance with the Aoki's practical equation. The distribution of strain sin-shape heat fluxes is useful for increasing the cooling efficiency in a nuclear reactor. The experimental results were in fair agreement with the calculated ones. (NSA of Japan)

6176 MATERIALS DEVELOPMENT WITH REFERENCE TO NUCLEAR REACTORS. Smith, Charles O. (Univ. of Detroit). Naval Eng. J., 79: 563-7(Aug. 1967).

Structural features of nuclear reactor components are reviewed, with reference to materials used in particular reactors. Physical and mechanical properties are determined, and nuclear properties of principal interest are neutron absorption, neutron scattering, and induced radioactivity. Corrosion resistance and phase diagrams are determined. INOR-8 (Hastelloy N, INCO-806) is cited as an example of successful materials development. Another example is MSRE (Molten Salt Reactor Experiment) graphite. (BBB)

6177 REVIEW OF APPROXIMATE TECHNIQUES IN NEUTRON THERMALIZATION AND TRANSPORT THEORY CALCULATIONS. Williams, M. M. R. (London Univ.). Nucl. Energy, 126-34(Sept.-Oct. 1967).

It is demonstrated that the scattering properties of the common moderators can be expressed very conveniently in terms of an equivalent phonon frequency spectrum. Certain common models of scattering are discussed. The well known synthetic kernel approximations of Horowitz and Cadilhac are derived and their range of validity briefly outlined. A collision probability method, based on the integral equation of neutron transport theory, is derived, and it is suggested that this is the most efficient method for dealing with lattice problems, particularly when several different and complex regions are involved. An approximate technique, the SPECTROX method, is discussed, which links diffusion theory in the moderator with collision probabilities in the fuel. The sensitivity of certain lattice parameters, i.e., disadvantage factors, temperature coefficients, etc., to the scattering model is illustrated by suitable examples. (auth)

6178 METHOD FOR THE MEASUREMENT OF THE ACTIVATION PERTURBATION OF ACTIVATION PROBES ON THE BASIS OF THE EXPERIMENTAL ALBEDO. Bensch, F.; Mantler, F.; Pilz, H. (Oesterreichische Hochschule, Vienna). J. Nucl. Energy, 21: 787-95(Oct. 1967).

The albedo concept introduced into neutron physics by Fermi has a close connection with the thermal flux depression caused by an absorber in a moderating medium. It is shown that it is possible to derive a theoretical relation of the so-called activation correction κ_c, as well as a simple and direct method for the experimental determination of κ_c. The k_c-values of gold foils of different diameters were measured in water and graphite in order to test the theoretical formula. The results are compared with values found by means of other theories. (auth)

6179 GENERALIZED PERTURBATION METHOD FOR BI-LINEAR FUNCTIONALS OF THE REAL AND ADJOINT NEUTRON FLUXES. Gandini, A. (Comitato Nazionale per l'Energia Nucleare, Casaccia, Italy). J. Nucl. Energy, 21: 755-65 (Oct. 1967).

A generalized perturbation method is derived with respect to ratios of bi-linear functionals of the real and adjoint neutron fluxes of critical multiplying systems. Simple linear analysis for optimization and sensitivity studies are then feasible relative to spectrum and space-dependent quantities, such as Doppler and coolant void reactivity effects in fast reactors. (auth)

6180 PRESSURE VESSEL THERMAL INSULATION. Friis, Ronald W.; Hench, John E. (to U. S. Atomic Energy Commission). U. S. Patent 3,357,890. Dec. 12, 1967.

Described is a thermal barrier structure for preventing overheating of a concrete nuclear reactor pressure vessel situated between the core and vessel wall in which spaced apart laminae project upwardly at an angle to the flow of heat from the core to the vessel wall. Coolant may be arranged to flow between the laminae in a direction counter to the direction of flow of heat from the core or to remain static and act in either case as a thermal insulation between laminae. (AEC)

6181 METHOD OF MAKING A DEVICE FOR MONITORING SHUT-DOWN NUCLEAR REACTORS. Quinlan, Frank B. (to U. S. Atomic Energy Commission). U. S. Patent 3,359,621. Dec. 26, 1967.

A method of preparing a safing wire for use in safeguarding a nuclear reactor to detect surreptitious use of the reactor is described. Strands of a relatively low melting metal, strands of a metal which will become radioactive when a neutron chain reaction occurs, and strands of a different metal are pulled through a tube, the last-mentioned strands being permitted to kink within the tube, and the tube is rotary swaged. (AEC)

6182 METHOD AND APPARATUS FOR CONTAINING RADIOACTIVE FLUID. Bell, Francis R.; Arthur, I. P. (to U. S. Atomic Energy Commission). U. S. Patent 3,356,580. Dec. 5, 1967.

A method and apparatus for containing a high pressure coolant stream of an operating nuclear reactor is described. Each penetration opening of the reactor pressure vessel is sealed with inner and outer sealing means, and higher pressure is continuously maintained in the region between said inner and outer sealing means. (AEC)

6183 NUCLEAR REACTOR. (to Gesellschaft fuer Kernforschung mbH) British Patent 1,093,134. Nov. 29, 1967. Priority date Aug. 1, 1964, Germany.

The description of a nuclear reactor having fuel elements of the rod bundle type with spacers arranged at different levels between the fuel rods is presented. The fuel elements are made of different compositions of fissile and fertile materials with the spacers connected to the fuel rods containing the high percentage of fertile material. The fuel rods are located at the intersections of a basic square lattice. (D.C.C.)

6184 IMPROVED PROTECTIVE SYSTEM FOR NUCLEAR REACTORS. (to Skoda, Narodni Podnik). British Patent 1,093,061. Nov. 29, 1967. Priority date Jan. 3, 1965, Czechoslovakia.

A protective tube for preventing thermal shocks in fuel channels during fuel element replacement is described. The tube is attached to the end of the fuel element, and as the fuel element is withdrawn the tube with heated cooling medium takes its place. The tube also serves to compensate for the increased neutron flux in surrounding fuel channel tubes when the spent fuel element is being removed. (D.C.C.)

6185 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Fray, Joseph (to United Kingdom Atomic Energy Authority). British Patent 1,093,029. Nov. 29, 1967. Filed July 10, 1964.

The descriptions of both large neutron absorbancy and small neutron absorbancy rods for reactor control are presented. The large neutron absorbancy control rods are tubular with the small absorbancy control rods co-positional within the bores of the large absorbancy rods and driven independently of the large absorbancy rods. The small absorbancy rods are intended for deep insertion in the reactor core during full-power operation for controlling excess reactivity. (D.C.C.)

6186 CONCRETE PRESSURE VESSEL TECHNOLOGY AND EXPERIENCE IN THE U. K. Davidson, I. (United Kingdom Atomic Energy Authority, London). 17p. (CONF-660450-4). DTIE.

From Advanced Gas-Cooled Reactor Symposium, Frankfurt am Main.

Principles and conventional practices involved in prestressing concrete structures are briefly examined. The history, application of prestressing principles, design, structural materials, and construction practices involved in the development of concrete vessels for nuclear reactors in the United Kingdom are summarized. (H.D.R.)

6187 NUCLEAR REACTOR CONTROL MECHANISM. Knights, Herbert Chilvers; Crockett, Peter Highnam; Sidebottom, William Joseph; Richardson, Alan (to United Kingdom Atomic Energy Authority). British Patent 1,090,632. Nov. 15, 1967. Filed Aug. 16, 1963.

The description of a reactor control mechanism which is fastened by a flexible line wound around a winch and opposed by a spring is presented. (D.C.C.)

6188 IMPROVEMENTS IN NUCLEAR REACTORS. (to Compagnie Francaise Thomson-Houston). French Patent 1,126,414(Add.2). Oct 2, 1961. Filed Oct. 30, 1959. 2nd Addition 76,587.

Vapotron-type fuel rods provided with massive longitudinal fins consisting of high density graphite are described. The cross section of the rods is triangular or star-shaped. The fins may be coated with electrodeposited metal. (NPO)

6189 IMPROVEMENTS IN NUCLEAR REACTORS. (to Compagnie Francaise Thomson-Houston). French Patent 1,126,414(Add.1). July 24, 1961. Filed July 2, 1959. 1st Addition 75,985.

The heat dissipating protuberances on Vapotron-type fuel elements consist of Mg, Al, or preferably sintered BeO. In a preferred embodiment the fuel rods consist of a single sintered piece with a core of UO_2 and a periphery of BeO. (NPO)

6190 IMPROVEMENTS IN NUCLEAR REACTORS. (to Compagnie Francaise Thomson-Houston). French Patent 1,126,414. July 30, 1956. Filed Feb. 16, 1955.

A pressurized water reactor in which the transmission of heat from the fuel elements takes place on the well-known Vapotron principle is described. The fuel rods are provided with massive fins, protuberances, or corrugations. The coolant is allowed to boil at the bases of the fins, but not at their apexes. The formation of a continuous film of vapor on the entire surface of the rods, leading to burnout, is prevented. (NPO)

6191 ANALYSIS OF SPACE AND ENERGY EFFECTS IN REACTOR FLUCTUATION EXPERIMENTS. Natelson, Michael. Ann Arbor, Mich., Univ. of Michigan, 1965. 102p.

Thesis.

Various measurements of the fluctuations in the neutron population of steady-state reactors have been performed in order to determine the kinetic properties of these reactors. The particular measurements considered here are the power-spectral-density (P.S.D.), the cross-power-spectral-density (C.P.S.D.) and the variance-to-mean (V/M). (Disser. Abstr.)

GENERAL

6192 (BNL–11684) LIGHT-INDUCED REACTIONS IN CHROMATIUM CHROMATOPHORES UNDER CONTROLLED REDOX CONDITIONS. Cusanovich, M. A.; Bartsch, R. G. (California Univ., La Jolla, San Diego. Dept. of Chemistry); Olson, J. M. (Brookhaven National Lab., Upton, N. Y.). [1967]. 19p. (CONF-670816–2). Dep. CFSTI.

From Conference on Comparative Biochemistry and Biophysics of Photosynthesis, Hakone, Japan.

Light-induced reactions of cytochromes in Chromatium were studied in relation to bacterial photosynthesis. It was found that many of the reactions of the Chromatium all could be duplicated with chromatophores and that individual reaction components could be more easily studied than was feasible with the whole cell. A list of 20 references to papers published during the report period is included. (H.L.W.)

6193 (BNL–11836) DYNAMICS AND STRUCTURE IN MOLECULAR CRYSTALS. I. SCATTERING METHODS AND INTERMOLECULAR FORCES: MODELS, TECHNIQUES, AND RESULTS. Hamilton, Walter C. (Brookhaven National Lab., Upton, N. Y.). [1967]. 61p. (CONF-671028–1). Dep. CFSTI.

From 2nd Symposium on Materials Research, Molecular Dynamics, and Structure of Solids, Gaithersburg, Md.

The application of neutron diffraction and inelastic scattering to problems in molecular structure and dynamics is discussed. The interaction between spectroscopy and diffraction and the use of theoretical models is emphasized. The relationship between vibrational amplitude as determined by diffraction and vibrational frequency as determined by spectroscopic techniques is shown to be relatively independent of the shape of potential function assumed. Little information concerning shapes can be derived from either type of experiment. The derived heights of potential barriers are extremely sensitive to the shape of the potential and the description of experimental results in terms of such barrier heights is often ambiguous. The quality of diffraction data is high enough so that the parameters of sensible models describing departures from harmonic motion can be refined from the diffraction data. Since internal modes are usually harmonic, it is suggested that the most suitable model for refinement of diffraction data may be one in which the vibrational amplitudes due to the internal modes are assumed and the remainder of the motion is refined in terms of anharmonic rigid body motions. Some speculation regarding the impact of neutron inelastic scattering on the study of intermolecular forces is presented. Experimental results on the motions of the phosphonium ion in phosphonium iodide and the ammonium ion in ammonium fluorosilicate are discussed. The interpretation of diffraction and spectroscopic data was greatly facilitated by numerical calculations of the crystal energy as a function of group orientation. It was concluded from an accurate neutron diffraction study that the short hydrogen bond in potassium hydrogen diaspirinate (bis-acetylsalicylate), a typical type A acid salt, is effectively of the symmetric single minimum type. An O–H stretching vibration of 500 to 1000 cm^{-1} is predicted. (auth)

6194 (BNWL-SA–1480) DRIFT AS A HAZARD IN AGRICULTURAL CHEMICAL USAGE: METEOROLOGICAL CONSIDERATIONS. Wolf, M. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 24, 1967. Contract AT(45-1)-1830. 9p. (CONF-671039–1). Dep. CFSTI.

From Agricultural Chemical Application Short Course Conference, Yakima, Wash.

Operational techniques applied to reduce the pesticide drift hazards are discussed, including observation of the behavior of a near surface smoke plume under several stability classifications and the application of the atmospheric diffusion theory for drift residues. Methods for minimizing drift on a local scale are available but investigations are needed to determine delayed drift and extended scale drift. (F.S.)

6195 (COO-1018-1116) COMMUNICATION NET OF MODULAR PROCESSORS FOR A MULTIPROCESSOR COMPUTER. Report No. 231. Chan, Shiu Kwong (Illinois Univ., Urbana. Dept. of Computer Science). June 1, 1967. Contract AT(11-1)-1018. 45p Dep. CFSTI.

A communication net of modular processors for the multiprocessor computer Illiac III is modeled in this paper. The model contains design features which allow the computer to operate with a variable number of modules, allow modules within a group to use alternate terminals so that when one terminal fails to function properly the module can be reattached to another one, and eliminate the hazard of the parallel access of the same module by two others where this is not allowed. All the requirements imposed on the communication net by the surrounding units are met, and an appropriate interface convention has been established. (auth)

6196 (COO–1469-0024) AN ELEMENTARY DISCUSSION OF THE TIME SHARE CONCEPT. Report No. 206. Holland, Lester M. Jr. (Illinois Univ., Urbana. Dept. of Computer Science). July 5, 1966. Contract AT(11-1)-1469. 23p. Dep. CFSTI.

The evolution of the time-share computer system is causing a dichotomy between user and system programmers. This is the result of making computers more accessible and easier to use from the user's viewpoint at the cost of requiring a complicated and intricate supervisor/monitor program to control the operations of the system. The various requirements of time-share systems including efficiency, communication, interaction, and supervisor programs are explained in terms of creating a utility computer system that can provide a computer service much as a telephone system provides a communication service. Two systems (Project MAC and the MULTICS system) are discussed in some detail to give an example of the evolution of time-share systems in the span of only a few years. (auth)

6197 (COO–1469-0034) COMPILER SYSTEMS AND META-LANGUAGES. Report No. 208. Squires, Burton E. (Illinois Univ., Urbana. Dept. of Computer Science). Aug. 1, 1966. Contract AT(11-1)-1469. 26p. Dep. CFSTI.

Trends and research activities to make compiling systems easier to describe, build and maintain, and to increase considerably their flexibility in relation to the user are described. A conceptual compiler-compiler is described in detail. Several of the theoretical and practical problems related to its construction are discussed and compared with actual systems in varying stages of implementation. Suggestions are made for future efforts in this area so that hopefully some day the user may be able to describe the linguistic features he prefers to use to describe his problem. (auth)

6198 (COO–1469-0046) TIME SHARING AT ILLINOIS: EXPERIENCE AND PLANS. Report No. 217. Gear, C. W. (Illinois Univ., Urbana. Dept. of Computer Science). Dec. 5, 1966. Contract AT(11-1)-1469. 14p. Dep. CFSTI.

The status of the experimental time-sharing system implemented on the ILLIAC II computer at Urbana is presented. Also, a new system consisting of IBM 360-50/75 main processors with links to other campus computers is described. (W.H.K.)

6199 (COO–1469-0067) ARTRIX FINAL REPORT. [Esch, J. W.; Irwin, A. F.; Kubitz, W. J.; Oberbeck, P. E.; Poppelbaum, W. J.; Rollenhagen, D. C. (Illinois Univ., Urbana. Dept. of Computer Science). May 24, 1967. Contract AT-(11-1)-1469. 219p. Dep. CFSTI.

The design and performance of the graphical processing system ARTRIX are presented. ARTRIX is a self-contained processing system employing both analog and digital circuitry. Digital outputs are easily provided, thus enabling ARTRIX to be used on-line with a computer. (W.H.K.)

6200 (COO–1668-3) MECHANISMS OF ION TRANSPORT AT THE SUBCELLULAR LEVEL WITH SPECIAL EMPHASIS ON THE ACTION OF PARATHYROID HORMONE. Progress Report, January 1, 1967–September 1, 1967. DeLuca, H. F. (Wisconsin Univ., Madison. Dept. of Biochemistry). Sept. 1, 1967. Contract AT(11-1)-1668. 6p. Dep. CFSTI.

Progress is reported on studies of the relation of vitamin D, parathyroid hormone, and thyrocalcitonin to the control of serum calcium and phosphate concentrations in normal and thyroparathyroidectomized rats. Preliminary results indicate that vitamin D induces the formation of a calcium transport system that moves calcium and phosphate from bone mineral to blood across osteocytes and that parathyroid hormone and thyrocalcitonin compete for membrane sites on these cells, controlling the release of calcium and phosphate into extracellular fluid. (C.H.)

6201 (CU–2530-10) DIETARY REGULATION OF PARATHYROID ACTIVITY. Clark, Irwin (Columbia Univ., New York. Coll. of Physicians and Surgeons). Oct. 3, 1967. Contract AT(30-1)-2530. 7p. Dep. CFSTI.

Alterations in parathyroid activity owing to modification of calcium to phosphate ratios in the diet were studied in relation to adsorption and excretion of Ca and P in adult rats fed a semi-synthetic diet. Increases in dietary Ca resulted in increase in the net amount of Ca adsorbed, the serum level of Ca, and Ca excretion in urine. Decreased phosphate adsorption and lowered phosphate levels in serum and urine following increased Ca intake were indicative of depressed parathyroid function. It is suggested that

the Ca to phosphate ratio in the serum may stimulate production of parathyroid hormones. (C.H.)

6202 (EGG-1183-1330) THE DIGITAL MICRODENSITOMETER AS AN OPTICAL SYSTEM COMPONENT. Tech Report L-848. Lorber, H. W. (EG and G, Inc., Las Vegas, Nev.). June 7, 1967. 43p. Dep. CFSTI.

The transfer properties of a digital microdensitometer are discussed. Information is presented for the optimization of digital microdensitometer parameters for specific photoprocessing tasks. (W.H.K.)

6203 (EUR-3634e) CONTRIBUTION TO THE PROGRAMMING OF THE CALCOMP DIGITAL INCREMENTAL PLOTTER FOR OFF-LINE OPERATION. Schmid, H. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Aug. 29, 1967. 85p. Dep.

The following computer programs for the off-line use of a Calcomp digital incremental plotter are described: an IBM 7090 subroutine PLOT in FAP which is compatible with the plotter subroutine package of P. Moinil and J. Pire of CETIS (Euratom Ispra) and which prepares magnetic tapes for the Calcomp magnetic tape unit 570, an IBM 1401 program in SPS which translates magnetic tape plotter data from CETIS code into original Calcomp code, and a set of plotter subroutines for the IBM 1401 computer in SPS. An example for the application of the IBM 1401 plotter subroutines is given. (auth)

6204 (IDO-17246) PROCEDURES FOR CONTROL OF SS NUCLEAR MATERIALS AT STATION JAC. Vest, E. T. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Oct. 1967. Contract AT(10-1)-205. 41p. Dep. CFSTI.

A manual of accountability procedures and data processing for Station JAC, NRTS. Station JAC includes LOFT, PBF, the SPERT reactors, and the FRAN Pump Burst Reactor. Computerized treatment of special nuclear and source material receipt and shipment are described; flow sheets are shown. The use of forms AEC-101, -284, and -388 is discussed. Internal transfer and expenditure forms are shown; use is described. Materials balance sheets are shown. Data treatment are reporting are detailed. Forecasting procedures are outlined. (M.L.S.)

6205 (KAPL-P-3373) COMPUTER INSTALLATION REPORT. Archibald, J. A. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 1967. Contract W-31-109-eng-52. 6p. (CONF-671013-1; CONF-671117-1; CONF-671204-1). Dep. CFSTI.

From Control Data Good Series Computer Users Group Meeting, Pittsburgh, Pa.; AEC Computer Information Meeting, Upton, N. Y.; General Electric Computer Users Association Meeting, Schenectady, N. Y.

The operation, software development, and applications of the CDC 6600 computer system is reported. The operation of the Philco 2000 system is briefly described. (B.G.D.)

6206 (LA-3741) NONDESTRUCTIVE DETECTION, IDENTIFICATION, AND ANALYSIS OF FISSIONABLE MATERIALS. Keepin, G. Robert (Los Alamos Scientific Lab., N. Mex.). Jan. 1967. Contract W-7405-eng-36. 17p. Dep. CFSTI.

Characteristic differences in relative group yields and energy spectra of delayed neutrons from the various fission species are used to provide unique methods for nondestructive detection, identification, and analysis of unknown mixtures of fissionable materials. Basically, these methods consist of detailed analysis (in time and, as a further refinement, in energy) of the measured delayed neutron activity from an unknown system following fast neutron irradiation. It is shown that such delayed neutron kinetic response measurements are largely free of the interfering and distorting effects inherent in other methods of detection and analysis. Besides practical applications to isotope identification and quantitative analysis in mixed systems, the methods are shown to be especially sensitive to fissile versus fertile ($k_\infty < 1$) fissionable materials—a distinction of practical importance in nuclear safeguards inspection and surveillance techniques. Full exploitation of the outlined methods promises a wide range of applications in the nuclear industry as well as in the emerging field of national and international nuclear safeguards and atomic energy control. (auth)

6207 (LA-3763) USING NONLINEAR LEAST-SQUARES METHODS FOR QUANTAL RESPONSE AND SENSITIVITY ANALYSES, MINIMUM CHI-SQUARE ESTIMATION, AND DIFFERENTIAL EQUATIONS. Moore, Roger H.; Zeigler, R. Keith (Los Alamos Scientific Lab., N. Mex.). Aug. 1, 1967. Contract W-7405-eng-36. 13p. Dep. CFSTI.

A number of special statistical and mathematical techniques reduce to solving equations equivalent to those required by general least-squares procedures. In the statistical category are quantal response and sensitivity analyses and minimum chi-square estimation of parameters; in the mathematical, is the problem of determining constants for differential equations whose solutions are relations among observable variables. This report contains demonstrations of the equivalences and provides examples to which the methods were applied. (auth)

6208 (LA-3805) SOME RECENT DEVELOPMENTS IN THE THEORY OF PHASE TRANSITIONS. Gruenberg, Leonard W. (Los Alamos Scientific Lab., N. Mex.). Oct. 1967. Contract W-7405-eng-36. 10p. Dep. CFSTI.

A discussion of the Landau theory of second-order phase transitions, generalized to take into account fluctuations, the breakdown of superfluidity in one and two dimensions, and the scaling laws is given. The discussion is based in part on the review article by L. P. Kadanoff, et al., Reviews of Modern Physics 39, 395 (1967). (auth)

6209 (NAA-SR-12525) EDIT: A FORTRAN IV LEVEL H PROGRAM TO PUNCH, PRINT, AND PLOT SELECTED PORTIONS OF AN ENDF/B DATA TAPE. Hubner, R. S.; Lemke, B. J. (Atomics International, Canoga Park, Calif.). Nov. 1, 1967. Contract AT(04-3)-701. 103p. (ENDF-105). Dep. CFSTI.

The EDIT program was written in FORTRAN IV Level H for the IBM System 360 Model 50 (S/360-50) computer. It will process selected materials and files on an ENDF/B EBCDIC data tape. Punching as well as printing may be requested for all seven files. Plotting with SC-4020 equipment may be requested for File 1 (first two sections) and Files 3 through 6. EDIT input and output are described. Examples of EDIT's use are given. (auth)

6210 (NP-17097) RESEARCH REPORT, 1965-1966. VOLUME I. SCIENCE AND AGRICULTURE. (Hebrew Univ., Jerusalem (Israel)). 714p. Dep.

Summaries are presented on various research activities in agriculture and science at the Hebrew University of Jerusalem during 1965 and 1966. (B.G.D.)

6211 (NYO-2902-10) SOMATIC MUTATIONS IN THE MOTH EPESTIA. Report on Research, September 15, 1966-August 15, 1967. Caspari, Ernst W. (Rochester Univ., N. Y.). Sept. 14, 1967. Contract AT(30-1)-2902. 18p. Dep. CFSTI.

The influence of 5-bromodeoxyuridine on the formation of abnormal scales was further studied. Labeled 5-BDU injected into last instar larvae is taken up by the nuclei of the wing buds. 5-bromodeoxyuridine and thymidine, injected into last instar larvae induce an immediate increase in the number of mitoses, followed by a decided drop in the number. The strain alba contains typical oval-shaped scales on the hind wing. In crosses, this characteristic shape of the scales behaves as a Mendelian recessive which cannot be separated from the eye-color gene alb. It is therefore either a pleiotropic effect of alb or due to a gene closely linked to it. Treatment of larvae heterozygous for alb with 5-BDU results in a large number of typical alb scales One large cluster of 20 alb scales was found. It is concluded that the alb scales represent true gene mutations induced by 5-BDU. Crosses testing the genetic relation between the genes Rt (purple testes), rt (red testes) and br (brown eyes) were continued. The results showed no recombination between Rt and br. It is concluded that these three genes represent a series of multiple alleles. The pigments of the testes were examined by paper chromatography. Rt contains a fast yellow component and a slow migrating purple component. rt-testes contain the same pigments but the purple component is reduced in amount. br-testes are missing the purple component, but contain an additional orange component which migrates somewhat more slowly than the yellow component. Attempts to induce wild type eyes or wing sectors in aa bb animals by injection of wild type DNA were unsuccessful. (auth)

6212 (NYO-3673-2) TRANSVERSE JET PLUMES. Technical Progress Report, November 1, 1966-November 30, 1967. Halitsky, James; Karmin, Irving; Liu, Stanley (New York Univ., N. Y. Geophysical Sciences Lab.). Dec. 1, 1967. Contract AT(30-1)-3673. 26p. Dep. CFSTI.

The structural phase of the water tower conversion to a field station was completed. The fixed platform and rotatable instrument carriage were assembled on the ground. Work on the air system for creating a plume was begun. The hollow riser which will serve as an air conduit between the fan on the ground and the test stack was opened and reinforced. Special instrumentation for the tunnel tests was built. The characteristics of the oscillating air stream produced in the tunnel by the vane mechanism were checked and a computer model for mathematically oscillating a steady-wind plume developed. No experiments were run since the field station was not ready. (F.S.)

6213 (NYO-3795-1) PROGRESS REPORT [ON PREPARATION AND PURIFICATION OF ERYTHROPOIETIN]. Binette, Paul; Prentice, T. C. (Buffalo General Hospital, N. Y.). Oct. 20, 1967. Contract AT(30-1)-3795. 4p. Dep. CFSTI.

Progress is reported on the preparation and purification of the erythropoietic stimulating factor from the blood serum of anemic rabbits. A procedure involving serum protein fractionation, gel filtration, and electrophoresis was modified to yield two protein peaks that are eluted in 5.0 ml. Although the two peaks have been separated, the bioassay of the fractions was not available. (H.G.D.)

6214 (ORNL-4151) MINIMAL WEINSTEIN DISCS IN A SUBSPACE. Morris, William Lewis (Oak Ridge National Lab., Tenn.). Nov. 1967. Contract W-7405-eng-26. 55p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

The problem of determining for a given matrix the minimal Weinstein Disc over all vectors from a specified subspace is analyzed. (W.H.K.)

6215 (ORNL-TM-2031) ENRICHED URANIUM PRICE SCHEDULES. Bennett, L. L.; Gift, E. H. (Oak Ridge National Lab., Tenn.). Oct. 31, 1967. Contract W-7405-eng-26. 63p. Dep. CFSTI.

The cost of enriched uranium has been calculated using $26/unit of separative work and a standard tails assay of 0.2% ^{235}U. This corresponds to AEC-announced values which are effective January 1, 1969. Tables of cost versus enrichment are presented for ore costs of 6, 8, 10, and $12/lb of U_3O_8. Cost of converting U_3O_8 to UF_6 was held constant at $2.70/kg uranium. Separative work and ore requirements are presented separately, thus making it easy to consider other ore costs or separative work charges. (auth)

6216 (ORO-3461-9) THE TOXICOLOGY OF NICKEL CARBONYL. Progress Report, July 1, 1967. Sunderman, F. William Jr. (Florida Univ., Gainesville. Dept. of Pathology). 10p. Dep. CFSTI.

Summaries are presented of investigations concerned with ultrastructural and histochemical studies of the alveolar reaction to nickel carbonyl; inhibition of cortisone induction of hepatic tryptophan oxygenase by nickel carbonyl; nickel carbonyl inhibition of phenobarbital induction of hepatic cytochrome P-450; effect of nickel carbonyl upon hepatic and pulmonary aminopyrine demethylase; nickel carbonyl inhibition of RNA polymerase activity in hepatic nuclei; metabolism of ^{63}Ni-labeled carbonyl, measurement of serum nickel; studies of carcinogenesis following parenteral injection of nickel carbonyl; measurement of Cu and Tl in biological materials by atomic absorption spectrometry; electrophoretic fractionation of serum proteins in hepatic diseases; and analysis of blood ethanol by gas chromatography. (B.H.S.)

6217 (PAEC(A)IN-672) IRON-59 (^{59}Fe). A Literature Search. (Philippine Atomic Energy Commission, Manila). July 1967. 76p. Dep.

A bibliography of 398 entries is presented on the properties and uses of iron-59. The references cited were abstracted in Nuclear Science Abstracts during the period March, 1947 to September, 1966. (W.H.K.)

6218 (SC-DC-67-2060) NOVEL FERROCENE POLYURETHANE. Fawcett, N. C.; Anderson, D. R.; Cassidy, P. E. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1967. Contract AT(29-1)-789. 16p. (CONF-670946-1). Dep. CFSTI.

From American Physical Society Meeting, Chicago, Ill.

The formulation of semirigid polyurethane foams using 27 wt % 1,1'-bis(α-hydroxyethyl)-ferrocene (BEF). Foam was obtained in two forms: nonoxidized and oxidized. Thermal and mechanical properties, along with other evidence, are offered in support of this oxidation. Possible inhibitions of oxidative degradation of the polymer backbone through sacrificial oxidation of ferrocine iron atoms is discussed. (M.C.G.)

6219 (SC-DC-67-2118) ESTIMATION OF UNKNOWN PROBABILITY DENSITY FUNCTIONS FROM OBSERVED DATA. Printiss, R. S. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1967. Contract AT(29-1)-789. 19p. Dep. CFSTI.

A stochastic approximation algorithm is used to estimate the probability density function of a random variable where the only information is a set of independent samples (measurements) of the random variable. A computer program was written which computes a set of coefficients for a truncated sine series approximation of the probability density function and the average value and variance of the random variable; it then plots the results of each approximation, which gives a picture of the nature of the convergence of the approximation scheme. It is shown that stochastic approximation methods result in a minimum mean-squared error approximation of a variable when certain assumptions about the variable can be made. A comparison between a known function and this program's estimate of that function is made, and calculations of the mean-squared error between the two functions are given. (auth)

6220 (SC-DC-67-2120) A DIGITAL PITCHING SECTOR CONTROL SYSTEM FOR THE SANDIA 18-INCH HYPERSONIC WIND TUNNEL. MacKenzie, Donald R. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1967. Contract AT(29-1)-789. 9p. (CONF-671021-1). Dep. CFSTI.

From 28th Supersonic Tunnel Association Meeting, Denver, Colo.

A new control system for operating the pitching sector of the Sandia 18-inch Hypersonic Wind Tunnel has been placed in operation. The system uses digital logic to provide continuous pitch or pitch-pause control over a maximum angle range of −10 to +20 degrees. Direct reading thumbwheel switches provide convenient digital adjustments of maximum pitch angle limits, pitch-increment angle, and pause time. (auth)

6221 (SC-DC-67-2234) A MASS STORAGE MAINTENANCE AND RETRIEVAL SYSTEM FOR DATA RELATED TO THE NONGRAPHIC PORTIONS OF ENGINEERING DRAWINGS, SPECIFICATIONS, AND CHANGE ORDERS. Horne, George D.; Stathis, John C. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1967. Contract AT(29-1)-789. 8p. Dep. CFSTI.

In order to effect a more rapid and accurate exchange of the nongraphic data associated with engineering drawings, releases, and change orders, the design and production agencies of the AEC's Albuquerque Operations Office formed an Ad Hoc Committee on Engineering Data Computerization. Using computers at all locations to process the data and to communicate the data between locations, the Computing Task Group has created a growing data base which must be updated daily and provide meaningful outputs for engineers and technical managers of the complex, as well as for AEC inspection officials. In order to effectively manage the data base, which includes hundreds of thousands of records, the programming staff, working jointly with IBM, has developed a mass storage data management software package for use with an IBM 7090 computer and the IBM 2302 disk file at Sandia Corporation, Albuquerque. The body of this presentation covers the principles which were used in formatting and assigning the disk areas, loading the disk with the original data base, maintaining the data base with additions, changes, and deletions, managing the problems of overflow, and a system of periodically unloading the file to tape as a protection against disk failure and to merge the overflow records with the main body of the file for reloading purposes. (auth)

6222 (SC-DR-67-803) NEAR FIELD NOISE OF AN F89 AIRCRAFT. Smallwood, D. O. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 38p. Dep. CFSTI.

Data are presented on the near noise field (5 to 100 feet) of an F89 aircraft with two engines (J-35) at 100-percent power with afterburners. These data are presented as a contour plot of the overall levels plus narrow-band and third-octave plots for each microphone location. The maximum overall level observed was 152 db re 0.0002 μbar. (auth)

6223 (SC-R-67-1219) FERROELECTRIC CERAMIC ELECTROOPTIC STORAGE AND DISPLAY DEVICES. Land, C. E. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1967. Contract AT(29-1)-789. 51p. (CONF-671037-1). Dep. CFSTI.

From International Electron Devices Meeting, Washington, D. C.

Certain newly developed, hot-pressed ferroelectric ceramics offer an apparently practical solution to the design of extremely high-density, optically interrogated, information storage devices. In addition to optical memory applications, the materials appear to be equally useful in high resolution, controlled-persistence displays, and in both electrooptic and acoustooptic modulation and deflection devices. The potential uses of these materials in a wide variety of optical devices and systems are made possible by their unique, electrically variable optical properties. Some of the optical and switching properties of hot-pressed lead zirconate–lead titanate (PZT) ceramics are described. A number of proposed optical devices are discussed, including a medium density memory which is in the research prototype stage of development. (auth)

6224 (SC-RR-67-799) PROBABILITY DISTRIBUTIONS FOR SUMS OF CERTAIN RANDOM VARIABLES, COMPARED TO THE GAUSSIAN APPROXIMATION. Belden, Glen W. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. 237p. Dep. CFSTI.

The probability distribution functions are calculated for the sum of N independent and identically distributed random variables for several special cases. The sum of N random variables which can assume the values 1 and 0 with probabilities p and q = 1 − p has a binomial distribution which is shown herein for N = 2(1)10(5)25(25)100(50)300 and for p = 0.1, 0.2, 0.5, 0.8, 0.9. Also, the distribution of a sum of N random variables with a uniform probability density function from 0 to 1 is shown for N = 2(1) 10(5)20. A measure of the error caused by approximating the distribution of the sum by a Gaussian distribution of the same mean and standard deviation is given by graphs of the ratio of the actual distribution function to the Gaussian distribution function for the values of N listed above. (auth)

6225 (SC-TM-67-765) DETECTION OF SHIFTS IN THE VALUES OF SATURATED STANDARD CELLS USED AS REFERENCES. McCallum, R. E.; Quinlan, R. E. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 30p. Dep. CFSTI.

A method for monitoring the stability of individual cells in reference groups has been developed and proven by large scale tests. If significant shifts in the voltages of the cells are shown to have occurred, certificate values can then be adjusted. Only data acquired in normal tests for certification of saturated standard cells are used. (auth)

6226 (SC-TM-67-775) ORGANIZATION 4631-1: CALIBRATION AND CERTIFICATION POLICY FOR STANDARD LEAKS AND VACUUM GAUGES. Ford, L. M. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1967. Contract AT(29-1)-789. 10p. Dep. CFSTI.

Sandia organization 4631-1 is a secondary standards laboratory for certifying and calibrating standard leaks and vacuum gages for Organization 2411, AEC integrated contractors, Sandia technical organizations, and Sandia suppliers. The capabilities and ranges of the equipment used are described and the reference standards used in the calibrations are listed. (F.S.)

6227 (SC-TM-67-867) ANALYSIS OF THE REPETITIVE IMPACT OF A BEAM WITH A RIGID BODY. Schmitt, Heinz W. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 15p. Dep. CFSTI.

An analysis is presented for the response of a Bernoulli–Euler beam to repetitive impacts with a rigid body. Specifically, the impact of the free end of a cantilever beam is considered though the analysis may be generalized for any beam type and impact point. The effects of beam preload and beam impact location are indicated. (auth)

6228 (SCL-DR-67-90) COMPUTERIZED BOOK CIRCULATION SYSTEM. Jacob, M. E.; Jacob, R. M. (Sandia Corp., Livermore, Calif.). Oct. 1967. Contract AT(29-1)-789. 48p. Dep. CFSTI.

This report describes the Sandia Livermore Technical Library circulation control system. The overall system design, conversion, and operation are discussed. Fuller details on actual programs and record formats are contained in the appendix. (auth)

6229 (SIT-3704-7) EFFECTIVE USE OF MASS MEMORY. Final Report. Flores, Ivan (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Electrical Engineering). Aug. 21, 1967. Contract AT(30-1)-3704. 4p. DTIE.

A study on how to best combine the various kinds of computer memory for an optimum system is presented in summary form. (W.H.K.)

6230 (SWRHL-34r) CALCIUM IN HOCK JOINTS OF WILDLIFE RUMINANTS IN SELECTED AREAS OF THE UNITED STATES. Brechbill, Raymond A.; Engel, Ronald E.; Kramp, Robert C. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). July 21, 1967. 15p. Dep. CFSTI.

The percent calcium of bone ash found in hock joints of 63 mule deer (Odocoileus hemionus), 14 white-tailed deer (Odocoileus virgianus), 14 elk (Cervus canadensis), 13 desert bighorn sheep (Ovis canadensis nelsoni), nine antelope (Antilocarpa americana), and seven buffalo (Bison bison) is reported. The average calcium content of hock joints in the six species from 18 different areas throughout the United States was 37.6% of bone ash. Differences between species, regardless of geographic locations, were small when present. (auth)

6231 (TID-3743) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Issued or in Progress During the Period September–October 1967. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 12p. DTIE Free.

A list of 59 bibliographies received by DTI Extension in September and October, 1967 are included. Also, 29 bibliographies in preparation are listed. (W.H.K.)

6232 (UCID-15212) PHOTOGRAPH DIGITIZING PROGRAM. Adams, James L. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 7, 1967. Contract W-7405-eng-48. 17p. Dep. CFSTI.

Photograph Digitizing Program (PDP) is a program that was designed for scanning photographs (transparencies), converting analog density information into 11 bit digital data, and storing this information point by point serially on magnetic tape. PDP will be useful, in general, for any project requiring digitized density information from photographic transparencies or any operator-selected subsquare area of them. (auth)

6233 (UCRL-7927-T) THE MOLECULAR PHYSIOLOGY OF CITRATE: A REVIEW OF THE DIVERSE METABOLIC ROLES OF CITRATE AND SOME DATA ON ITS FORMATION BY BONE. Srere, Paul A. (California Univ., Livermore. Lawrence Radiation Lab.). [1964]. Contract W-7405-eng-48. 29p. Dep. CFSTI.

A review and discussion of data relating to the three newly recognized metabolic functions of citrate: source of reducing power, source of acetyl groups for biosynthetic pathways, and controlling (activator or inhibitor) substance for a number of enzymes, in animal tissues are presented. Data concerning the enzymes of citrate metabolism in bone (citrate synthase and ATP citrate lyase), and several of the problems of citrate metabolism and its control are also reviewed and discussed. (75 references) (B.H.S.)

6234 (UCRL-13321) CLEANSWEEP III B AIR LAUNCHED PARTICULATE AIR SAMPLING ROCKET SYSTEM. Final Report No. TR67-1500-1. (Zimmey Corp., Monrovia, Calif.). Sept. 1967. Contract W-7405-eng-48; Subcontract 298. 58p. Dep. CFSTI.

For Univ. of California Lawrence Radiation Lab., Livermore.

Work done to incorporate certain desirable design changes in the Cleansweep III B payload is described. Each item of the scope of work is related to the resulting drawing or activity. Certain techniques employed in foaming and casting of the dye marker are presented in detail. A few recommendations are also presented. A list of drawings and a parts list are included as appendices. (auth)

6235 (UCRL-17841) CHOICE OF COORDINATE SYSTEM IN ELIPSOMETRY. Muller, Rolf H. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1967. Contract W-7405-eng-48. 8p. Dep. CFSTI.

A discussion to clarify and unify the coordinate system used in the analysis of elliptic polarization of reflected light is presented. (W.H.K.)

6236 (UCRL-17884) TIMING CODE FOR CONTINUOUS DAY COUNTING. Robinson, H. P. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1967. Contract W-7405-eng-48. 10p. (CONF-671023-1). Dep. CFSTI.

From Range Commanders Council, White Sands Missile Range, Fort Huachuca, Ariz.

A description of a time code that is equivalent in information content and bandwidth requirements to the IRIG Format A is given. The difference is in the use of days and decimals of a day instead of days, hours, minutes, and seconds. Some historical material is included. A plea for the use of atomic timekeeping in research, military and space applications is made. (auth)

6237 (UCRL-70510) ON HAYKIM'S METHOD FOR RC-ACTIVE FILTER SYNTHESIS. Wujek, Joseph H, Jr. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 15, 1967. Contract W-7405-eng-48. 10p. (CONF-671041-1). Dep. CFSTI.

From 5th Allerton Conference on Circuit and System Theory, Chicago, Ill.

A method has been demonstrated by Haykim whereby RC-active filters are synthesized with predetermined pole sensitivity. For a quadratic transfer function, sensitivity is independent of the damping ratio, ζ. Moreover, the method uses a nonideal amplifier in the sense that finite and nonzero input impedance is permitted. Several properties related to the synthesis development are presented. In particular, expressions for the boundedness of the pole sensitivity parameters are developed. A theorem for a necessary condition for Haykim-relizability is also given. Finally, the effects of nonzero output impedance and severe gain variations are illustrated for a second-order Butterworth filter. (auth)

6238 (Y-1A-50) IMPROVEMENT, MANAGEMENT, AND CONTROL OF THE BUILDING SERVICES FUNCTION. Hayes,

R. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Sept. 25, 1967. Contract W-7405-eng-26. 12p. (CONF-671014-1). Dep. CFSTI.

From Industrial Seminar, Ames, Iowa.

A study to improve the function of the Building Services Department for industrial sanitation at Y-12 is presented. (W.H.K.)

6239 (ANL-Trans-532) CONTRACTION OF CIRCULAR LIQUID JETS. Trefftz, E. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Z. Math. Phys., 64: 34-61 (1916). 29p. Dep. CFSTI. JCL $2.60 fs, $1.07 mf.

An analysis was made to determine the jet by which an incompressible liquid flows out of the circular hole in the horizontal bottom of a large vessel. (M.O.W.)

6240 (LA-tr-67-87) HISTONES OF RICE EMBRYOS. Tsuchiya, Toshio; Iwai, Koichi; Ando, Toshio. Translated for Los Alamos Scientific Lab., N. Mex., from Seikagaku, 39: 109-16(1967). 18p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Rice embryos, after being treated repeatedly with 0.14M NaCl solution, were extracted in 1.5M NaCl solution. The extract contained string-shape dioxylipo-nucleoprotein consisting of about equal quantities of DNA and histone, which was then extracted in dilute acid to obtain histone. The dilute acid extract of nucleoprotein showed typical histone properties from filter paper electrophoresis and characteristic color reactions using $HgSO_4$–H_2SO_4 and $NaNO_2$. A dissolution chromatograph of the dilute acid extract of nucleoprotein in a carboxylmethylcellulose column yielded three histone fractions, i.e., high lysine, high arginine (major constituent), and extra high arginine. The histone, overall, was a high arginine type. The chromatographic fractions of histone were apparently different from the equivalent fractions obtained from calf's chest gland histone. The total histone was also different. It also showed characteristics that were different from wheat embryo histone reported in literature. Defatted rice embryos were extracted directly in dilute acid and an attempt was made to purify the extract by a chromatographic method or isoelectric precipitation method; however, no histone fractions with fixed properties were obtained by these methods. (auth)

6241 (LA-tr-67-107) CONDENSATION PRODUCTS OF FURFURYL ALCOHOL. VII. INFRARED ABSORPTION SPECTRA OF FURAN DERIVATIVES. Takano, K. Translated for Los Alamos Scientific Lab., N. Mex., from Nippon Kagaku Zasshi, 82: 373-6(1961). 13p. Dep. CFSTI. JCL $1.60 fs, $0.89 mf.

Infrared absorption spectra were measured on 2-substituted and 2,5-disubstituted furan derivatives found in the early stage condensation products of furfuryl alcohol. It was found from the measurements that characteristic absorption bands of 2,5-disubstitutes are at 1567 to 1550 and 990 to 960 cm^{-1}. (auth)

6242 (LA-tr-67-108) EMULSIFICATION OF FURFURYL ALCOHOL–WATER–ACID CATALYST SYSTEM. Tsuruta, S.; Takano, K. Translated for Los Alamos Scientific Lab., N. Mex., from Kogyo Kagaku Zasshi, 58: 1008-12(1955). 17p. Dep. CFSTI. JCL $1.60 fs, $1.01 mf.

The emulsification phenomenon of furfuryl alcohol-water-acid catalyst system was investigated, and the results compared with those of the phenolic resin system. The area concerning phenolic resins for which there was no data was also investigated and the findings reported. The HCl catalyst system was investigated at various acid concentrations and temperatures. Emulsification curves were determined using 10 organic acids and 3 inorganic acids as catalysts. (D.H.M.)

6243 (NRC-TT-1296) HIGH PRESSURE PHYSICS AS BASIC RESEARCH. Kuss, E. Translated by D. A. Sinclair (National Research Council of Canada, Ottawa), from Chimia (Aarau), 18: 75-89(1964). 35p. Dep. CFSTI. CAN.

Discussions are presented on the following: (1) the law of mass effect and the role of the pVT data and the equations of state, (2) viscosity and its importance for the reaction rate, and (3) the structure of compressed gases, liquids, and solids. (M.O.W.)

6244 (UCRL-Trans-10141) AVALANCHE, HALT: THE MEMOIRS OF A BLASTER. Dokuchaev, Mikhail. Translated by T. Lazar for Univ. of California Lawrence Radiation Lab., Livermore, from Lavina, Ostanovis: (Vospominaniya Vzrynika), Isdatel'stvo, Sovetskaya Rossiya, Moscow, 1965. 137p. Dep. CFSTI. JCL $10.50 fs, $4.37 mf.

The phenomena and techniques of industrial blasting are described. Blasting as used to break rock in mining ores and quarrying construction materials; breaking ground to build canals, dams, and reservoirs; fracturing and forging metals; demolishing old buildings; uprooting tree stumps; deepening river beds; and building islands in the sea is discussed. (F.S.)

6245 (WAPD-Trans-78) SHIFT OF LIQUID INCLUSION IN A CRYSTAL IN THE DIRECTION OF HEAT SOURCE. Lemmlein, C. G. Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from Dokl. Akad. Nauk SSSR, 85: 325-8(1952). 9p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

A process for closing fissures in crystals was studied using a sodium nitrate crystal and microcinematography. The material needed to close the fissure is taken from the wall of the fissure and the energy needed for this rearrangement of the crystal is a part of the released excess of surface energy of the crystal–solution system in the capillary fissure. Parts of the saturated solution being reserved as a result of the closing of fissures, the liquid inclusion, usually continue to change their shape in the direction of reducing the surface and acquiring stable crystalline surfaces with minimum surface energy. Elongated inclusions with a significant excess of surface tend to reduce the surface of the cavity. A part of the released energy in the form of heat radiates into space. Small interstitial inclusions proved sensitive to this increase in temperature. (M.C.G.)

6246 THE AEC'S PROGRAM IN INDUSTRIAL APPLICATIONS OF RADIATION AND RADIOISOTOPES. Mott, William E. (Atomic Energy Commission, Washington, D. C.); Rotariu, George J. Isotop. Radiat. Technol., 4: 317-20(Summer 1967).

The primary objective of the Division of Isotopes Development's industrial applications program is to induce advances in radiation and radioisotopes technology leading to economic industrial applications in the public interest. A secondary objective is to increase the number and scope of specific practical applications so that industry will have as broad an opportunity as possible to start profitable ventures. The decision to support a proposed industrial application (technique, instrument, or process) rests largely on the value or advantage the end product of the proposed effort would have over existing methods or practices. (auth)

6247 AEC-DID EIGHTH ANNUAL CONTRACTORS MEETING: ISOTOPES SYSTEMS DEVELOPMENT. Baker, P. S. Isotop. Radiat. Technol., 4: 380-8(Summer 1967).

On Dec. 5 through 7, 1966, the AEC's Division of Isotopes Development (DID) held its eighth annual contractors meeting dealing with isotope systems development. In the three-day session, 39 reports of character work were presented, and there were four panel discussions. Eight presentations dealt with basic technology development, with the remainder of the program covering systems engineering; analytical methods; marine device development; environmental applications; industrial applications; aerospace applications; and national security applications. The Systems Development Program was initiated in 1958 with the objective of accelerating the development of new principles and techniques of isotope applications, with particular emphasis upon public benefit problems. The objective has remained essentially the same over the years, but recently the Advisory Committee on Isotopes and Radiation Development has recommended that some of the effort be directed toward the assurance that the developed technology will actually be picked up and used. Although major emphasis was upon the Systems Engineering or direct applications area, particularly on those projects in which an end user is assured and on problems that solve significant problems in government and industry for which an end user is involved, DID continues to support unsolicited ideas in the areas of Basic Technology and Analytical Methods, despite the fact that end users may not be explicitly identified. (auth)

6248 RADIOISOTOPE PROGRAM OF THE INTERNATIONAL ATOMIC ENERGY AGENCY. Gerrard, Martha. Isotop. Radiat. Technol., 4: 430-1(Summer 1967).

The International Atomic Energy Agency (IAEA) uses large radioisotope sources as well as tracers in its work. Among the programs currently being sponsored by the IAEA is the use of radioisotope sources for disinfestation of grain and processing of other foods, sterilization of pharmaceuticals and medical supplies, remote therapy of cancer, and insect control by the sterile-male-release technique. Tracer studies include those in hydrology, fertilizer utilization, and nutrition. (auth)

6249 IAEA SAFEGUARDS INSPECTION. McKnight, A. D. (International Atomic Energy Agency, Vienna). Neue Tech., 9: 198-204(Oct. 1967).

Description of the Agency's Safeguards System and an account of executive administration of safeguards, including both technical and non-technical aspects with mention of impact of safeguards on operator, are presented. (auth)

6250 TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY 1967 WINTER MEETING, NOVEMBER 5-9, 1967, CHICAGO, ILLINOIS. Farmakes, Ruth (ed.). Trans. Amer. Nucl. Soc., 10: 413-734(Nov. 1967). (CONF-671102).

A total of 363 papers were presented at the conference. Separate abstracts were prepared for each paper. (J.R.D.)

For abstracts of individual chapters see: 4017–4023, 4082–4085, 4172, 4240, 4280–4282, 4314–4325, 4344–4349, 4356–4360, 4369–4378, 4383–4394, 4396–4418, 4432–4438, 4490, 4508–4512, 4561, 4562, 4738–4744, 4753, 4779, 4802, 4821–4838, 4847, 4856–4860, 4876–4878, 4906–4914, 5400–5405, 5690, 5714–5749, 5793, 5824–5832, 5883, 5884, 5937–6026, 6068, 6071–6088, 6100–6125, and 6140–6167.

6251 HIGH TEMPERATURE ROCK DRILL. Armstrong, Dale E.; Coleman, Jack S.; McInteer, Berthus B.; Potter, Robert M.; Robinson, Eugene S. (to U. S. Atomic Energy Commission). U. S. Patent 3,357,505. Dec. 12, 1967.

A high temperature rock drill is described having a tubular housing, a tungsten disc closing one end of the housing with a central orifice located therein, an electrically connected flat coiled tungsten heater placed adjacent to the disc and imbedded in a thin layer of boron nitride, a guide tube of smaller diameter located within the housing and concentric to the orifice, and pneumatic means for removing melted material through the guide tube. (AEC)

6252 PRESSURE SENSITIVE SWITCH. Ayers, Alan N. (to U. S. Atomic Energy Commission). U. S. Patent 3,358,605. Dec. 19, 1967.

A pressure sensitive electrical switch is described that is hermetically sealed and which includes a contact arm having a pair of bellows associated with it in a manner to prevent the contact arm from vibrating. Means are provided for adjusting to small pressure changes which are transmitted to the switch through a conduit. (AEC)

6253 RATCHET DRIVE. Christianson, C. A. (to U. S. Atomic Energy Commission). U. S. Patent 3,358,519. Dec. 19, 1967.

A ratchet drive that maintains stub means and pawl means always in contact with the outside edge of a toothed ratchet wheel to prevent overriding beyond rotation of the wheel one tooth width at a time is described. In one embodiment the drive of this invention is advantageously used for a quick acting, precise, foolproof and remote drive for the insertion of targets into accelerator beams. (AEC)

6254 IMPROVEMENTS IN OR RELATING TO ELECTRIC SWITCHES. Alston, Liviu Leonard; Millar, William; Mosson, Gordon Alfred George (to United Kingdom Atomic Energy Authiy, L don). British Patent 1,091,204. Nov. 15, 1967. Filed Nov. 27, 1963.

An electric switch designed to carry 100 kA and 20C with little jitter is described. The switch is composed of electrode plates which wafer insulators and a metallic layer so constructed that when a voltage is applied from an auxiliary source the insulator is ruptured and current flows. (W.H.K.)

Appendix I

JOURNAL LIST

The following list includes 1968 additions to the comprehensive list published in NSA, Volume 22, No. 1, January 15, 1968. In the future, comprehensive lists will be published once each year (in January), and current additions will be cumulated on a monthly basis (in alternate issues) until the next comprehensive list is issued.

The title abbreviations are based on the United States of America Standards Institute's REVISED AND ENLARGED WORD-ABBREVIATION LIST FOR USASI Z39.5–1963 AMERICAN STANDARD FOR PERIODICAL TITLE ABBREVIATIONS. Titles of journals that are scanned regularly for NUCLEAR SCIENCE ABSTRACTS are marked by an asterisk (*). Foreign-language journals identified by a dagger (†) are available in English translation. The original-language title for a translated journal is given in parenthesis after the English title.

Acta Anat. Nippon.
Acta Anatomica Nipponica
see Kaibogaku Zasshi

Acta Med. Iugoslav.
Acta Medica Iugoslavica *(Yugoslavia)*

Acta Pharm. Hung.
Acta Pharmaceutica Hungarica *(Hungary)*

Astrofizika
Astrofizika *(Armenian S.S.R.)*

Astrophys. Lett.
*Astrophysical Letters *(Scotland)*

At. Energy (China)
Atomic Energy (China)
see Yuan Tzu Neng

Berg- Huettenmaenn. Monatsh. Montan. Hochsch. Leoben
Berg- und Huettenmaennische Monatschefte der Montanistischen Hochschule in Leoben *(West Germany)*

Boll. Zool.
Bollettino di Zoologia. Pubblicato dall'Unione Zoologica Italiana *(Italy)*

Bull. Astron.
Bulletin Astronomique *(France)*

Bull. Belgicatom
Bulletin Belgicatom (formerly Belgicatom, Association Belge pour le Developpement Paficique de l'Energie Atomique, Bulletin d'Information) *(Belgium)*

Bull. Kyoto Educ. Univ., Ser. B
Bulletin of the Kyoto Educational University, Series B. Mathematics and Natural Science *(Japan)*

Bull. Res. Inst. Miner. Dressing Met., Tohoku Univ.
Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University
see Tohoku Daigaku Senko Seiren Kenkyusho Iho

Bus. Week
Business Week *(U. S.)*

Can. J. Psychol.
Canadian Journal of Psychology *(Canada)*

Chim. Ind., Genie Chim.
Chimie et Industrie, Genie Chimique (formed by the merger of Chimie et Industrie (Paris) and Genie Chimique (Paris)) *(France)*

Chin. Anim. Husb. Vet. Med.
Chinese Animal Husbandry and Veterinary Medicine
see Chung Kuo Hsu Mu Shou I

Chung Kuo Hsu Mu Shou I
Chung Kuo Hsu Mu Shou I (Chinese Animal Husbandry and Veterinary Medicine) *(China)*

Coal Age
Coal Age *(U. S.)*

Commer. Fish. Rev.
Commercial Fisheries Review *(U. S.)*

Desalination
Desalination *(Netherlands)*

Elec. World (Shanghai)
Electrical World *(Shanghai)*
see Tien Shih Chieh

Elektromedizin
Elektromedizin und Ihre Grenzgebiete *(Germany)*

Engei Gakkai Zasshi
Engei Gakkai Zasshi (Journal of the Japanese Society for Horticultural Science) *(Japan)*

Entropie
Entropie *(France)*

Ergonomics
Ergonomics *(England)*

Farm, Ranch, Home Quart.
Farm, Ranch and Home Quarterly *(U. S.)*

Forest. Abstr.
Forestry Abstracts *(England)*

Fortschr. Zool.
Fortschritte de Zoologie *(West Germany)*

Geofys. Sb.
Geofysikalni Sbornik *(Czechoslovakia)*

Harper Hosp. Bull.
Harper Hospital Bulletin *(U. S.)*

Hoken Butsuri
Hoken Butsuri (Journal of Japan Health Physics Society) *(Japan)*

Honvedorvos
Honvedorvos *(Hungary)*

Hyogo Noka Daigaku Kiyo
Hyogo Noka Daigaku Kiyo (Memoirs of the Hyogo University of Agriculture) *(Japan)*

Indian J. Appl. Chem.
Indian Journal of Applied Chemistry *(India)*

India J.Occup. Health
Indian Journal of Occupational Health *(India)*

Izobret., Prom. Obraztsy, Tovarnye Znaki
Izobreteniya, Promyshlennye Obraztsy, Tovarnye Znaki *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Geol.
Izvestiya Akademii Nauk SSSR, Seriya Geologicheskaya *(U.S.S.R.)*

J. Aust. Ceram. Soc.
Journal of the Australian Ceramic Society *(Australia)*

J. Balneol. Soc. Jap.
Journal of the Balneological Society of Japan
see Onsen Kagaku

J. Forensic Med.
Journal of Forensic Medicine *(South Africa)*

J. Irrig. Drain. Div., Amer. Soc. Civil Eng.
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